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All communications relating to this Journal should be addressed to the Director of the College of Agriculture.

List of Lepidoptera of the Islands Tanegashima and Yakushima.

By

Nobukatsu Marumo.

With Plate III.

The four great islands that constitute Japan proper are mostly included within the palaearctic region, though insects belonging to the oriental region are also richly found over these islands. Especially in southern parts, i.e. Kii of Honshiu, Tosa of Shikoku as well as Hyuga, Osumi and Satsuma of Kiushiu, the characteristics of the latter region are emphasized.

Two small islands Yakushima and Tanegashima belonging to Kagoshima Prefecture, forming Kumage District, lie about 60 miles off southwards from Kagoshima City, though the distance between the headland of Sata of Kiushiu and the nearest spot of Tanegashima is at most within 30 miles. Notwithstanding the approachment of these islands and Kiushiu there is a great difference in their flora: there are found a good deal of tree-ferns throughout the wood and the banians on their coast of the former. The mangroves are also seen growing at the mouth of the Kuma river of Tanegashima.

Although the plants of Tanegashima are almost all in common with those of Yakushima, it is very characteristic that the pine-trees are almost entirely wanting in the latter in which they are replaced by the well-known Cryptomeria trees, called "Yakusugi." The island Yakushima is about 15 miles in the distance across, in the centre of which a steep high granitic mountain called Miyanoura (about 1900 m.) arises, while the island Tanegashima is a long table-land (about 35 miles long) without remarkable mountains.

The difficulty of separating the flora of the islands, also exists in the study of their insect fauna, and investigating the lepidopterous insects of the two islands I could come to the conclusion that in the fauna the two islands

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just stand between those of Kiushiu and Loochoo Islands* (belong to the oriental region), rather nearer situating to the former than to the latter. IWATA who had studied the butterflies of this district (Tanegashima and Yakushima) stated that the boundary line between the Loochoo Islands and Kiushiu probably lie southwards from these islands. I can express my agreement with his opinion. The oriental lepidopterous insect such as *Hebomoia glaucippe, Junonia almana, J. orithya, Nacaduva atrata, Melanitis phedisma* and the species of the genera, *Callidula, Doratoptera* and *Nyctemera* are represented in this district, and no species belonging to the genera *Hebomoia, Callidula* and *Doratoptera* which are considered to have origin in the oriental region have hitherto been found in Japan proper. But the most lepidopterous insects distributed over these islands are common with those found in the four great islands of Japan and the local form of species comes nearer to that of the palæarctic than to the oriental region. These facts indicate me the faunal feature of this district.

As I have been interested in the insect fauna of this district I made repeated excursions to these islands, one in July 1918 and the other in June 1919. In addition to mine the late Dr. T. MIYAKE made a collecting in August 1909 and the late Mr. K. HABUTSU in September 1910. All these materials collected by these two gentlemen have also been placed at my disposal.

The total number of species enumerated in this paper is 179, of which 45 are Rhopalocera and the rest 134 are Heterocera, of which 7 appear to be new to science and their descriptions are given in their proper systematic position. Several examples collected which are undetermined, are not enumerated in this paper. I must express my hearty thanks to the late Dr. T. MIYAKE who offered generously his private list to my study.

* Including Amami Oshima.

Fam. **Lithosiadæ.**

Subfam. NOLINAE

Nola trilinea. n. sp.

(Pl. III, fig. 1.)

♂. White. Palpi brown at sides. Antennæ bipectinate to before apex. Forewings with the costa brown; terminal area suffused with brown; crests of scales at middle and at upper angle of cell slightly tinged with brown; antemedial line slight, brown, angled outwards in cell; medial line brown, distinct from lower angle of cell to inner margin; postmedial line brown, more or less punctiform, excurved below costa and at vein 5; subterminal line very indistinct, suffused with brown on its inner side; cilia brownish with a dark line through them. Hindwings white suffused with brownish towards termen; cilia brownish. Underside whitish; forewings more or less strongly and hindwings slightly suffused with brownish fuscous.

Expanse 18 mm.

A male type taken by me at Noma, Tanegashima, July 11, 1919.

Subfam. LITHOSIANAE.

Lexis immaculata.

Katha immaculata Butl. P.Z.S. 1880, p. 671; Kirby, Cat. Het. p. 329; Leech, Trans. Ent. Soc. 1899, p. 184; Hmpsn. Cat. II. p. 118, pl. 21. f. 8.

A male taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Kiushiu (Nagasaki, Yakushima); Honshiu?

General distribution. Japan; Corea; Formosa; Malay.

Ilema affineola.

Lithosia affineola Brem. Lep. Ost—Sib. p. 97, pl. 8. f. 5 (1864); Seitz, Seitz, Macrolep. II. p. 67, pl. 12 k; Hmpsn. Cat. Suppl. I. p. 504.

Manulea calamaria Moore, P.Z.S. 1878, p. 18.

Katha aprica Butl. Cist. Ent. III. p. 115. (1885).

Ilema sororcula Hmpsn. (part). Cat. II. p. 185 (1900).

A male and a female of *aprica* form taken by me at Nishinoomote, Tanegashima, July 25 and 26, 1918.

Local distribution. Hokkaido; Honshiu.

General distribution. Japan; Loochoo; China; Siberia; India.

Asura intermedia. n. sp.

(Pl. III. fig. 2.)

Yellow. Thorax without black points; fore tibiæ and tarsi banded with black at the tip. Forewings with a black point at base; subbasal and curved antemedial series of black points; a medial oblique series of black points; a highly and irregularly dentate postmedial black line strongly bent outwards below costa and to inner margin, with long teeth on veins 4, 6 and 7; a subterminal series of black points, the spot on vein 4 is situated near termen. Hindwings hyaline slightly suffused with yellow.

Expanse ♂ 18, ♀ 21 mm.

A male type taken by me at Miyanoura, Yakushima, July 12, 1918. Several males and females also from Yakushima, July 1918.

Closely allied to *Asura obsoleta* Moore.

Subfam. Arctianæ.

Diacrisia subcarnea.

Spilosoma subcarnea Walk. Cast. III. p. 675 (1855); Butl. Ill. Het. B.M. III. p. 6, pl. 42. f. 8; Leech, Trans. Ent. Soc. 1899, p. 149; Hmpsn. Cat. III. p. 215; Seitz, Seitz, Macrolep. II. p. 85, pl. 15 d.

Aloa bifrons Wlk. Cat. III. p. 705 (1855).

Aloa leucothorax Feld. Wien. ent. Mon. VI. p. 36 (1862).

Spilosoma erubescens Moore, A.M.N.H. (4) XX. p. 89 (1877).

Spilosoma rybakowi Alph. Rom. Mém. IX. p. 171, pl. 10. f. 9 (1897).

Hyarias oberthuri Semp. Schmett. Phil. II. p. 489 (1899).

Two males and females taken by Habutsu in Yakushima, August 1910.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea; China; Philippines; Celebes.

Utetheisa pulchella.

Tinea pulchella Linn. Syst. Nat. 10 ed. p. 534 (1758); Kirby, Cat. Het. p. 346; Leech. Trans. Ent. Soc. 1899, p. 170; Staud. Cat. pal. p. 373; Hmpsn. Cat. III. p. 488, Seitz, Seitz, Macrolep. II. p. 73, pl. 13 k.

Noctua pulchra Den, et Schiff. Wien. Verz. p. 68 (1776).

Geometra lotrix Cram. Pap. Exot. II. pl. 109, E, F (1779).

Deiopeia pulchella var. *candida* Butl. Trans. Ent. Soc. 1877, p. 361.

Deiopeia thyster Butl. Trans. Ent. 1877, p. 361.

Utetheisa pulchella ab. *pallida, fasciata, semisignata, melampyga* Spuler, Schmett. Eur. II. 143 (1910).

Utetheisa pulchella tenuella Seitz, Seitz, Macrolep. II. p. 73, pl. 13 k.

Many specimens of *tenuella* form taken by me at Nishinoomote, Tanegashima, July 26 and 28, 1918. They aggregated on the flowers of *Vitex trifolia* grown on the coast of Tanegashima.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; India; Philippines; Malay; New Guinea; Australia; Europe etc.

Fam. **Noctuidæ.**

Subfam. Hadeninæ.

Cirphis flavostigma.

Xanthia flavostigma Brem. Lep. Ost-Sib. p. 52, pl. 5. f. 11 (1864); Leech, Trans. Ent. Soc. 1900, p. 123; Hmpsn. Cat. V. p. 509; Warren, Seitz, Macrolep. III. p. 96, pl. 24 c.

Leucania singularis Butl. A.M.N.H. (1) I. p. 80 (1878), Ill. Het. B.M. II. p. 22, pl. 28. p. 11.

A female taken by me on Mt Miyanoura, Yakushima, July 16, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Corea; Formosa; China; Siberia; India.

Subfam. ZENOBIANÆ.

Delta intermedia.

Cloantha intermedia Brem. Lep. Ost—Sib. p. 53, pl. 5. f. 13 (1864); Hmpsn. Cat. VIII. p. 192; Warren, Seitz, Macrolep. III. p. 202, pl. 42 c.

Auchmis sikkimensis Moore, P.Z.S. 1867, p. 49, pl. 6. f. 15.

A male taken by me at Nishinoomote, Tanegashima, July 26, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Siberia; India.

Subfam. ERASTRIANÆ.

Phyllophila obliterata.

Anthophila obliterata Rmbr. Ann. Soc. Ent. Fr. 1833, p. 27, pl. 2. f. 17; Staud. Cat. pal. p. 230; Hmpsn. Cat. X. p. 383; Warren, Seitz, Macrolep. III. p. 274, pl. 51 k.

Anthophila wimmerii Treit. Eur. Schmett. X. 2, p. 148 (1835).

Anthophila recta Ev. Faun. Volg. Ur. p. 338 (1844).

Phyllophila cretacea Butl. Ill. Het. B.M. III, p. 28, pl. 47. f. 11 (1879).

A male of *cretacea* form taken at Miyanoura, Yakushima. July 12, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Siberia; Persia; Europe.

Lithacodia signifera.

Acontia signifera Wlk. Cat. XII. p. 793 (1857); Moore, Lep. Ceyl. III. p. 47, pl. 150. f. 4; Leech, Trans. Ent. Soc. 1900, p. 145; Hmpsn. Cat. X. p. 504; Warren, Seitz, Macrolep. III. p. 276, pl. 51 m.

A male taken by me at Kosugitani, Yakushima, July 20, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; India; Australia.

Naranga ænescens.

Naranga ænescens Moore, P.Z.S. 1881, p. 359; Hmpsn. Cat. X. p. 632, pl. 168. f. 3; Warren, Seitz, Macrolep. III. p. 282, pl. 51 n.

A male taken by me at Noma, Tanegashima, June, 16, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Formosa; China.

Subfam. PHLOGOPHORINÆ.

Phlogophora sinuosa.

Phalga sinuosa Moore, P.Z.S. 1881, p. 375, pl. 37. f. 7; Hmpsn. Cat. XI. p. 17. f. 10.

Eutelia viridinota Swinhoe, Trans. Ent. Soc. 1895, p. 52.

A male taken by me at Kusukawa, Yakushima, July 20, 1918.

Local distribution. Honshiu; Kiushiu (Yakushima).

General distribution. Japan; Borneo; India.

Subfam. CATOCALINÆ.

Catocala prægnax.

Catocala prægnax Wlk. Cat. XIII. p. 1213 (1857); Butl. Ill. Het. B.M. III. pl. 46. f. 11; Leech, Trans. Ent. Soc. 1900, p. 534; Hmpsn. Cat. XII. p. 165; Warren, Seitz, Macrolep, III. p. 317, pl. 57 c.

A female taken by me at Kaminaka, Tanegashima, June 12, 1919.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Siberia.

Erebus crepuscularis.

Noctua crepuscularis Linn. Syst. Nat. 12 ed. 1, 2, p. 811 (1767); Leech, P.Z.S. 1889, p. 544; Fritze, Faun. Liu-Kiu-Ins. p. 66; Hmpsn. Cat. XII. p. 292; Warren, Seitz, Macrolep. III. p. 322, pls. 58 d, 59 a.

Nyctipao ephesperis Hübn. Verz. p. 272 (1827).

Nyctipao lætitia Butl. Ill. Het. B.M. III. p. 26, pl. 47. f. 9 (1879).

A female taken by me at Kusukawa, Yakushima, July 20, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu; Shikoku.

General distribution. Japan; Loochoo; China; Andamans; Sumatra; Borneo; Philippines; Java; New Guinea.

Metopta rectifasciata.

Spirama rectifasciata Mén. Cat. Lep. Het. Mus. Petr. pl. 17. f. 6 (1863); Leech, Trans. Ent. Soc. 1900, p. 575; Hmpsn. Cat. XII. p. 301; Warren, Seitz, Macrolep. III. pl. 58 c, d.

Spirama japonica Wlk. (nec Guen). Cat, XXXIII. p. 948 (1865).

Spirama interlineata Butl. A.M.N.H. (5) 1. p. 291; Ill. Het. B.M. II. p. 41, pl. 34. f. 2.

Common in both Yakushima and Tanegashima.

Local distribution. Hokkaido; Honshiu; Kiushiu; Shikoku.

General distribution. Japan; Corea; Formosa; China.

Ophisma gravata.

Ophisma gravata Guen. Noct. III. p. 237 (1852); Hmpsn. Cat. XII. p. 542; Warren, Seitz, Macrolep. III. p. 328.

A female taken by HABUTSU in Tanegashima, August 1910.

Hitherto unrecorded from Japan.

Local distribution. Kiushiu (Tanegashima.)

General distribution. Japan; Loochoo; China; Malay; India.

Parallelia curvata.

Ophiusa curvata Leech, P.Z.S. 1889, p. 546, pl. 58. f. 8; Hmpsn. Cat. XII p. 578; Warren, Seitz, Macrolep. III. p. 328, pl. 612.

Four females taken by me at Jurokuban and Noma, Tanegashima, June 10, 11 and 15, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Loochoo; Corea.

Chalciope hyppasia.

Noctua hyppasia Cram. Pap. Exot III. pp. 99, pl. 250. f. E (1779); Leech, Trans. Ent. Soc. 1900, p. 567; Hmpsn. Cat. XIII. p. 27; Warren, Seitz, Macrolep. III. p. 332, pl. 61 f.

Phalæna deliana Stoll. Cram. Pap. Exot. V. pt 160, pl. 36. f. 4 (1790).

Ophiusa anfractuosa Boisd. Faun. Ent. Madag. Lep. p. 104, pl. 15. f. 6 (1833).
Trigonodes acutata Guen. Noct. III. p. 283, pl. 22. f. 6 (1852).
Trigonodes inacuta Guen. Noct. III. p. 284 (1852).
Trigonodes compar Wlk. Cat. XIV. p. 1451 (1858).

A female taken by me at Noma, Tanegashima, June 11, 1919.

Hitherto unrecorded from Japan.

Local distribution. Kiushiu (Yakushima).

General distribution. Japan; Loochoo; Formosa; China; Philippines; Sumatra; India; Australia; Africa etc.

Mocis undata.

Noctua undata Fabr. Syst. Ent. p. 600 (1775); Hmpsn. Cat. XIII. p. 91; Warren, Seitz, Macrolep. III. p. 333, pl. 612.
Phalœne archesia Stoll, Cram. Pap. Exot. III. p. 146, pl. 273. f. 14 (1870).
Ophiusa mayeri Boisd. Faun. Ent. Madag. p. 104 (1834).
Remigia pellita Guen. Noct. III. p. 319 (1852).
Remigia gregalis Guen. Noct. III. p. 320 (1852).
Remigia mutuata Wlk. Cat. XIV. p. 1505 (1858).
Remigia jugalis Wlk. Cat. XIV. p. 1505 (1858).
Hypætra diffundens Wlk. Cat. XXXIII. p. 963 (1865).
Remigia associata Wlk. Cat. XXXIII. p. 1010 (1865).
Remigia inconcisa Wlk. Cat. XXXIII. p. 1913 (1865).
Remigia bifasciata Wlk. Cat. XXXIII. p. 1014 (1865).
Ophiusa subœnescens Wlk. Proc. Nat. Hist. Soc. Glasg. I. p. 361, pl. 6. f. 9. (1873).
Cauninda undata subsp. *bifasciata* Warren, Seitz, Macrolep. III. p. 333 (1913).

A male taken by Habutsu in Yakushima, August 1910.

Local distribution. Hokkaido; Honshu; Kiushu.

General distribution. Japan; Corea; Formosa; China; Philippines; Java; India; Africa.

Mocis anneta.

Remigia anneta Butl. A. M. N. H. (5) I. p. 293 (1878); Ill. Het. B. M. II. p. 43, pl. 34. f. 7; Leech, Trans. Ent. Soc. 1900, p. 564; Staud. Cat. Pal.

p. 240; Hmpsn. Cat. XIII. p. 102; Warren, Seitz, Macrolep. III. p. 334, pl. 61 g.

A male taken by me at Kusukawa, Yakushima, July 20, 1918.

Local distribution. Hokkaido; Honshiu; Kiushu; Shikoku.

General distribution. Japan, Corea; China; Siberia.

Subfam. PHYTOMETRINÆ.

Phytometra daubei.

Plusia daubei Boisd. Gen. et Ind. Meth. p. 159 (1840); Staud. Cat. pal. p. 289; Hmpsn. Cat. XIII. p. 477.

Plusia ciliaris Wlk. Cat. XII. p. 928 (1857); Butl. Ill. Het. B. M. VI. p. 36, pl. 110. f. 5.

A male specimen taken by MIYAKE.

Local distribution. Kiushiu (Tanegashima or Yakushima).

Hitherto unrecorded from Japan.

General distribution. Japan; India; Europe.

Subfam. NOCTUINÆ.

Thermesia ussuriensis.

Remigia ussuriensis Brem. Lep. Ost-Sib. p. 61, pl. 5. f. 19 (1864); Leech, Trans. Ent. Soc. 1900, p. 569; Warren, Seitz, Macrolep. III. p. 381, pl, 69 e.

Two females taken by me at Miyanoura, July 12, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu; Shikoku.

General distribution. Japan; Corea; China; Siberia.

Hypocala subsatura.

Hypocala subsatura Guen. Noct. III. p. 75 (1852); Leech, Trans. Ent. Soc. 1900, p. 545; Warren, Seitz, Macrolep. III. p. 382, pl. 69 F.

Hypocala aspersa Butl. P. Z. S. Lond. 1883. p. 164.

Hypocala subsatura var. *limbata* Butl. Ill. Het. VII. p. 76, pl. 131. f. 13 (1899).

A male of the typical form taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China; India.

Oræsia emarginata.

Noctua emarginata Fabr. Ent. Syst. III. 2, p. 82; Hampsn. Moths Ind. II. p. 564; Leech, Trans. Ent. Soc. 1900, p. 578; Warren, Seitz, Macrolep. p. 383, pl. 69 h.

Oræsia alliciens Wlk. Cat. XII, p. 945 (1857).

Oræsia tentans Wlk. Cat. XII. p. 945 (1857).

Oræsia metallescens Guen. Noct. II. p. 364 (1852).

A female taken by me in Yakushima, July 11, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; India.

Oræsia excavata.

Calpe excavata Butl. A. M. N. H. (5) I. p. 202 (1878); Ill. Het. B. M. II. p. 35, pl. 32. f. 1 (1878); Leech, Trans. Ent. Soc. 1900, p. 579; Warren, Seitz, Macrolep. III. p. 384, pl. 69 h.

A male taken by me at Nishinoomote, Tanegashima, July 23, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China.

Plusiodonta cœlonota.

Plusiodonta cœlnota Koll. Hüg. Kasch. IV. p. 482; Hmpsn. Moths Ind. II. g. 578; Leech, Trans. Ent. Soc. 1900, p. 590; Warren, Seitz, Macrolep. III. p. 384, pl. 70 a.

Plusiodonta chalsytoides Guen. Noct. II. p. 36).

Deva conducens Wlk. Cat. XII. p. 963.

Plusia agens Feld. Reis. Nov. pl. 110, f. 32 (1874).

A male taken by me at Nishinoomote, Tanegashima, July 27, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Loochoo; Corea; China; India; Java.

Subfam. POTYPOGONINÆ.

Pseudaglossa pryeri.

Herminea pryeri Butl. Ill. Het. B. M. III. p. 63, pl. 56. f. 11 (1879); Leech, Trans. Ent. Soc. 1900, p. 616; Warren, Seitz, Macrolep. III. p. 414. pl. 74 f.

A female taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Honshiu; Kiushiu.

Habitat. Japan.

Edessena hamada.

Ranodes hamada Feld. Reis, Nov. pl. 119. f. 23 (1874); Leech, Trans. Ent. Soc. 1900, p. 628; Warren, Seitz, Macrolep. III. p. 414, pl. 72 a.

A female taken by me at Nishinoomote, Tanegashima, July 23, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China.

Dichromia trigonalis.

Dichromia trigonalis Guen. Delt. et Pyr. p. 19 (1854); Hmpsn. Moths Ind. III. p. 73 (1895); Leech, Trans. Ent. Soc. 1900, p. 648; Warren, Seitz, Macrolep. III. p. 427, pl. 72 h, i.

Dichromia sextalis Wlk. Cat. XVI. p. 15 (1858).

Common in both Yakushima and Tanegashima.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; Formosa; China; India.

Fam. **Liparidæ.**

Porthesia pulverea.

Artaxa pulverea Leech, P. Z. S. 1888, p. 623, pl. 31. f. 5; Fritze, Faun. Liu-Kiu. Ins. p. 65; Trans. Ent. Soc. 1899, p. 140; Straud, Seitz, Macrolep. II. p. 136, pl. 21 F.

Took a male (expanse 20 mm.) at Nishinoomote, Tanegashima, July 25, and a female (expanse 36 mm.) on Mt. Miyanoura, Yakushima, July 16, 1918.

In my collection there are two males and a female taken at Nachi, Kii (Honshiu) and Komori, Yamato (Honshiu).

In the hindwings the vein 5 is absent.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Loochoo; Corea.

Porthetria dispar.

(Pl. III, fig. 3.)

Bombyx dispar Linn. Syst. Nat. 10 ed. p. 501 (1758); Kirby, Cat. Het. p. 475; Leech, Trans. Ent. Soc. 1899, p, 130; Straud, Seitz, Macrolep. II. p. 127, pl. 10 d.

Bombyx disparina Müll. Faun. Siles. III. pl. 3. f. 1 (1802).

Lymantria fasciata Rebel, Berge's Schmett. p. 118.

Lyparis dispar var. *bordigalensis vel disparoides* Mab. Gasch. Bull. et Ann. Soc. Ent. Fr. (5) VI. pp. IX, 521 (1876).

Ocneria dispar ab. *semiobscura, erebus* Mieg. La Nat. VIII. p. 237 (1876).

Lymantria dispar insignata, angulifera, unifascia, submarginalis Schultz, Ent. Zeitschr. Stutt. XXIV. pp. 35–36.

Liparis dispar var. *japonica* Motsch. Etud. Ent. 1860, p. 31.

Lymantria sinica Moore, P. Z. S. 1879, p. 403.

Lymantria fumida Butl. A. M. N. H. (4) XX. p. 402; Ill. Het. B. M. II. pl. 24. f. 4♀; Trans. Ent. Soc. 1881, p. 11♂.

Porthesia umbrosa Butl. Trans. Ent. Soc. 1881, p. 10.

Lymantria dispar ab. *wladiwostockensis* Strand, Seitz, Macrolep. II. p. 127, pl. 20 C.

A male with abnormally white hindwings taken by me at Kusukawa, Yakushima, July 21, 1918.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Palæarctic and Arctic regions; North America.

Porthetria nobunaga.

Lymantria nobunaga Nagano, Nawa, Insect World. XVI. p. 262, pl. 14. figs. 1, 2 (1912).

A male taken by me in Yakushima, July 13, 1918.

Local distribution. Honshiu (Kii, Mino); Kiushiu (Yakushima).

Habitat. Japan.

Fam. **Callimorphidæ.**

Nyctemera mundipicta.

Nyctemera mundipicta Wlk. Journ. Linn. Soc. Lond. Zool. III. p. 184 (1859); Kirby, Cat. Hat. I. p. 421.

MIYAKE stated he has seen an example at Miyanoura, Yakushima, August 1909.

Hitherto unrecorded from Japan.

Local distriction. Kiushiu (Yakushima).

General distribution. Japan; Java; Malay.

Nyctemera plagifera.

Nyctemera plagifera Wlk. Cat. II. p. 400; Butl. Ill. Het. B. M. V. p. 45, pl. 88. f. 3; Hmpsn. Moths Ind. II, p. 47; Fritze, Faun. Liu-Kiu-Ins. p. 65; Leech, Trans. Ent. Soc. 1899. p. 169; Seitz, Seitz, Macrolep II. p 103, pl. 18 h.

A female taken by HABUTSU in Yakushima, August 1910.

Local distribution. Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; India.

Nyctemera cenis.

Geometra cenis Cram. Pap. Exot. II. pl. 147. f. E (1779?); Kirby, Cat. Het. I. p. 423; Hmpsn. Moths Ind. II. p. 48.

Nyctemera interlecta Wlk. Cat. II p. 400; Butl. Ill. Het. B. M. V. p. 45, pl. 88. f. 2.

A female taken by HABUTSU, August 1910, and also by me, July 13,

1918, in Yakushima. The species are very common at Jurokuban, Tanegashima, in June.

Hitherto unrecorded from Japan.

Local distribution. Kiushiu (Yakushima, Tanegashima).

General distribution. Japan; Loochoo; Formosa; Yunnan; India.

Fam. **Sphingidæ.**

Subfam. SPHINGINÆ.

Herse convolvuli.

Sphinx convolvuli Linn. Syst. Nat. 10 ed. p. 490 (1758); Hmpsn. Moths Ind. I. p. 103: Fritze, Faun. Liu-Kiu-Ins. p. 63; Leech, Trans. Ent. Soc. 1898, p. 286; Roths. et Jord. Rev. Shin. p. 11; ford. Seitz, Macrolep. II, p. 233, pl. 36 a.

Sphinx abadonna Fabr. Ent. Syst. Suppl. p. 435 (1798).

Sphinx roseofasciata Koch. ind. Austr. Lep. Faun. p. 54 (1865).

Sphinx pseudoconvolvuli Schaufuss, Nung. Otios. p. 15 (1870).

Sphinx distans Butl. Lep. N. Zeal. p. 4, pl. 2. f. 11 (1874).

Proctoparce orientalis Butl. Trans. Zool. Soc. Lond. IX. p. 609 (1877).

Sphinx convolvuli var. *batatæ* Christ. Mitth. Schw. Ent. Ges. VI. p. 346 (1884).

Sphinx convolvuli var. *alicea* Neuburger, Ill. Zeitschr. Ent. IV. p. 297 (1899).

Sphinx convolvuli var. *nigricans* Cannaviello, Bull. Soc. Ent. Ital. XXXII. p. 295 (1900).

Argrius convolvuli var. ichagensis, tahitiensis, minor, major, grisea, unicolor, intermedia, fuscosignate, virgata, variegata, suffusa, obscura Tutt. Brit. Lep. IV. (1904).

Five males taken by MIYAKE in Yakushima, August 1909.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa ?; Borneo; Java; Celebes; India; Europe.

Subfam. SECIANÆ.

Cephonodes xanthus.

Cephonodes xanthus Roths. et Jord. Rev. Sphin. p. 465, pl. 5. f. 17 ♀ (1903).

Two males taken by HABUTSU in Tanegashima, August 1910 and I have also received a female from the same locality.

Local distribution. Kiushiu (Tanegashima).

General distribution. Japan; Loochoo.

Subfam. MACROGLOSSINÆ.

Gurelca masuriensis.

Lophura masuriensis Butl. P. Z. S. 1875, p. 244, pl. 36, f. 3; Hmpsn. Moths Ind. I. p. 110; Leech, Trans. Ent. Soc. 1898, p. 291; Roths. et Jord Rev. Shin. p. 589; Jord. Seitz, Macrolep. II. p. 251.

Lophura himachala Butl. P. Z. S. 1875, p. 621.

Lophura erebina Butl. P. Z. S. 1875, p. 621.

Lophura sangaica Butl. P. Z. S. 1875, p. 621; Jord. Seitz, Macrolep. II. p. 251, pl. 40 g.

A male taken by HABUTSU in Tanegashima, August 1910.

Local distribution, Honshiu; Kiushiu.

General distribution. Japun; Corea; Formorsa; China; India.

Gurelca hyas.

Lophura hyas Wlk. Cat. Viii. p. 107 (1856); Hmpsn. Moths Ind. I. p. 110; Leech, Trans. Ent. Soc. 1898, p. 291; Roths. et Jord. Rev. Sphin. p. 588; Jord. Seitz, Macrolep. II. p. 251, pl. 40 g.

Macroglossum geometricum Moore, Cat. Lep. Ins. Mus. E. I. C. I, p. 265 (1857).

Perigonia macroglossoides Wlk. Cat. XXXV. p. 1851 (1866).

A male specimen.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Formosa; China; Java; India.

Macroglossum pyrrhosticta.

Macroglossa pyrrhosticta Butl. P. Z. S. 1875, p. 242, pl. 36, f. 8; Fritze. Faun. Liu-Kiu-Ins. p. 62; Leech, Trans. Ent. Soc. 1898, p. 293; Roths. et Jord. Rev. Sphin. p. 641, pl. 3. f. 12; Jord. Seitz, Macrolep. II. p. 253, pl. 40 f.

Macroglossa gilia Boisduval, Spec. Gen. Lep. Het. I. p. 341 (1875).

Macroglossa catapyrrha Butl. P. Z. S. 1875, p. 243, pl. 36. f. 6.

MIYAKE records this species in his own list.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Loochoo; Lombok; India.

Subfam. CELERIANÆ.

Theretra oldenlandiæ.

Sphinx oldenlandiae Fabr. Syst. Ent. p. 542 (1775); Moore, Lep. Ceyl. II. p. 17, pl. 85, f. 85; Hmpsn. Moths Ind. I. p. 87; Leech, Trans. Ent. Soc. 1898, p. 283; Roths. et Jord. Rev. Sphin. p, 781; Jord. Seitz, Macrolep. II. p. 259, pl. 42 b.

Sphinx drancus Cram. Pap. Exot. II. pl. 132. f. F (1777).

Sphinx argentata Stephens, Ill. Brit. Ent. Haust. I. p. 130 (1828).

Chærocampa puellaris Butl. P. Z. S. 1875, p. 623.

Chærocampa firmata Wlk. Cat. VIII. p. 148 (1856).

Chærocampa argentata Butl. P.Z. S. 1875, p. 8, pl. 2. f. 3.

A male taken by MIYAKE.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; China; Philippines; Java; India; New Guinea; Australia.

Theretra silhetensis.

Chærocampa silhetensis Wlk. Cat. VIII. p. 143 (1858); Butl. Ill. Het. B. M. V. pl. 79, f. 6; Leech, Trans. Ent. Soc. 1898, p. 284.

Sphinx pinastrina Martyn, ined. (1797).

Chærocampa bisecta Moore, Cat. Lep. Mus. E. I. C. I. p. 278 (1857).
Chærocampa intersecta Butl. P. Z. S. 1875, p. 623.

Two males.

Local distribution. Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; Philippines; Borneo; Java; India.

Fam. **Ceruridæ.**

Ramesa straminea.

Ceira straminea Moore, A. M. N. H. (4) XX. p. 91 (1877); Leech, Trans. Ent. Soc. 1898, p. 301; Grünberg, Seitz, Macrolep. II. p. 316, pl. 47 g. Marumo, Journ. Coll. Agr. Imp. Univ. Tokyo. VI. p. 343.

A male taken by me at Noma, Tanegashima, June 13, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China.

Fam. **Geometridæ.**

Subfam URAPTERYGINÆ.

Tristrophis subpunctaria.

Urapteryx subpunctaria Leech, Entom. XXIV. Suppl. p. 42 (1891); A. M. N. H. (6) XIX. p. 192, pl. 6. f. 2; Prout, Seitz, Macrolep. IV. p. 336, pl. 17 f.

A male taken by me on Mt. Miyanoura, Yakushima, July 15, 1918.

Local distribution. Honshiu; Kiushiu.

Habitat. Japan.

Thinopteryx crocoptera.

Urapteryx crocoptera Koll. Hüg. Kasch. IV. p. 483 (1848); Hmpsn. Moths Ind. III. p. 148; Leech, A. M. N. H. (6) XIX. p. 193; Prout, Seitz, Macrolep. IV. p. 336, pl. 17 f.

Thinopteryx striolata Butl. Journ. Linn. Soc. Zool. XVIII. p. 202 (1883).

A male taken by me at Kosugitani, Yakushima, July 19, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; India.

Synegia esther.

Synegia esther Butl. Trans. Ent. Soc. 1881, p. 411; Leech, A. M. N. H. (6) XIX. p. 204; Prout, Seitz, Macrolep. IV. p, 319.

A female taken by me in Yakushima, July 13, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China.

Synegia hadassa.

Anisodes hadassa Butl. A. M. N. H. (5) I. p. 400 (1878); Ill. Het. B. M. III. p. 38, pl. 50. f. 8; Leech, A. M. N. H. (6) XIX. p. 204.

Synegia inconspicua Butl. Trans. Ent. Soc. 1881, p. 412.

Syntaracta hadassa ab. *unicolor* Wileman, Trans. Ent. Soc. 1911, p. 299, pl. 31. f. 26.

Synegia hadassa suffusa Prout, Seitz, Macrolep. IV. p. 318.

Two males of the *inconspicua* form taken by me at Kosugitani, Yakushima, July 14 and 15, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; China.

Scionomia mendica.

Cidaria mendica Butl. A. M. N. H. (5) IV. p. 446 (1879): Leech, A. M. N. H. (6) XIX. p. 226; Prout, Seitz, Macrolep. IV. p. 338.

A female taken by me in Yakushima, July 14, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; China.

Zethenia rufescentaria.

Zethenia rufescentaria Motsch. Etud. Ent. p. 35 (1866); Leech, A. M. N. H. (6) XIX. p. 223; Prout, Seitz, Macrolep. IV. p. 330, pl. 16 d, e.

Zethenia consociaria Christ. Bull. Mosc. 1880, p. 66.

A male taken by me at Kosugitani, Yakushima, July 14, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Corea; Siberia.

Heterolocha laminaria.

Urapteryx laminaria H.-Schäff. Syst. Schmett. Eur. VI. p. 71 (1843-1856).
Hyperythra(?) aristonaria Wlk. Cat. XX. p. 130 (1860).
Hyperythra niphonica Butl. Ill. Het. B. M. II. p. 46, pl. 35. f. 11 (1878).
Heterolocha laminaria bicolor Prout, Seitz, Macrolep. IV. p. 340.

A male and four females taken by me at Nishinoomote and Noma, Tanegashima, July 26, 1918, and June 10 and 11, 1919.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Persia; Asia Minor.

Corymica specularia.

Caprilia specularia Moore, P. Z. S. 1867, p.649, pl. 33. f. 11; Hmpsn. Moths Ind. III. p. 186; Leech, A. M. N. H. (6) XIX. p. 298; Prout, Seitz, Macrolep. IV. p. 339.
Thiopsyche pryeri Butl. A. M. N. H. (5) 1. p. 393; Ill. Het. B. M. III. p. 29, pl. 48. f. 2.
Corymica vitrigera Butl. Ill. Het. B. M. VII. p. 101, pl. 135. f. 14 (1889).

A male taken by me in Yakushima, July 14, 1918.

Local distribution. Honshiu, Kiushiu.

General distribution. Japan; China; India.

Spilopera gracilis.

Endropia gracilis Butl. A. M. N. H. (5) IV. p. 371 (1879); Hmpsn. Moths. Ind. III. p. 190; Leech, A. M. N. H. (6) XIX. p. 300; Prout, Seitz, Macrolep. IV. p. 345. pl. 18. e.

A female taken by me at Kosugitani, Yakushima, July 14, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Formosa; Corea; China; India.

Rhynchobapta flaviceps.

Nadagara flaviceps Butl. Trans. Ent. Soc. 1881, p. 419; Hmpsn. Moths Ind. III. p. 195; Leech, A. M. N. H. (6) XIX. p. 303; Prout, Seitz, Macrolep, IV. p. 345, pl. 18 e.

A male taken by me at Nishinoomote, Tanegashima, July 26, 1918.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; China; India.

Macaria pluviata.

Macaria pluviata F.; Prout, Seitz, Macrolep. IV. p. 348.

Macaria sufflata Guen. Phal. II. p. 88, pl. 17. f. 8. (1857).

Macaria hebesata Wlk. Cat. XXIII. p. 931 (1861); Butl. Ill. Het. B. M. III. pl. 52. f. 1.

Macaria sinicaria Wlk. Cat. XXVI. p. 1650 (1862).

Macaria breviusculata Wlk. Cat. XXVI. p. 1650 (1862).

Macaria proditaria Brem. Lep. Ost-Sib. p. 81, pl. 7. f. 7. (1864).

Macaria maligna Butl. A. M. N. H. (5) 1. p. 405 (1878); Ill, Het. B. M. III. p. 45, pl. 52. f. 3.

Gonodela horridaria Moore, Lep. Atk. p. 262 (1888).

Common in Tanegashima in June and July.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; Siberia; China; India.

Tephrina semilutata.

Eubolia semilutata Led. Sib. Schmett. p. 29, pl. 6. f. 3 (1853); Meyrick, Trans. Ent. Soc. 1892, p. 103; Leech, A. M. N. H. (6) XIX. p. 311; Prout, Seitz, Macrolep. IV. p. 406.

Chœrodes dictynna Butl. Ill. Het. B. M. II. p. 45, pl. 35. f. 7 (1878).

A male and three females taken by HABUTSU in Yakushima, and Tanegashima, August and September, 1910.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Siberia.

Arichanna jaguararia.

Arichanna jaguararia Guen. Phal. II. p. 198 (1857); Leech, A. M. N. H. (6) XIX. p. 439; Prout, Seitz, Macrolep. IV. p. 305, pl. 14 c.

Very common at Kosugitani, Yakushima, in July.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China.

Abraxas miranda.

Abraxas miranda Butl. A. M. N. H. (5) I. p. 441 (1878); Ill. Het. B. M. III. p. 48, pl. 52. f. 12; Prout, Seitz, Macrolep. IV. p. 311. pl 15 b.

Abraxas latifasciata Warr. Novit. Zool. I. p. 419 (1894).

Abraxas suffusa Warren, Novit. Zool. I. p. 417 (1894).

Abraxas sylvata ab. *continuata* Warren, Novit. Zool. X. p. 269 (1903).

A female taken by me on Mt. Miyanoura, July 18, 1918.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; Siberia; India; Europe.

Subfam. PSYCHOPHORINÆ.

Asthena erectaria.

Cidaria erectaria Leech, A. M. N. H. (6) XIX. p. 651 (1897); Prout. Seitz, Macrolep. IV. p. 273, pl. 7 g.

A female taken by me at Kosugitani, Yakushima, July 14, 1918.

Local distribution. Hokkaido; Honshiu (Yamato); Kiushiu (Yakushima).

Habitat. Japan.

Cidaria saturata.

Larentia saturata Guen. Phal. II. p. 269 (1857); Hmpsn. Moths Ind. III. p. 362; Leech, A. M. N. H. (6) XIX. p. 652; Prout, Seitz, Macrolep. IV. p. 227, pl. 7 f.

Larentia exliturata Wlk. Cat. XXIV. p. 1195 (1862).

Coremia livida Butl. A. M. N. H. (5) I. 449; Ill. Het. B. M. III. p. 56, pl. 55. f. 2.

Larentia inamœna Butl. A. M. N. H. (5) IV. p. 444 (1879).

A female of *livida* form taken by me at Kosugitani, Yakushima, July 18, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution Japan, China: India; S. Africa.

Photoscotosia atrostrigata.

Scotosia atrostrigata Brem. Lep. Ost-Sib. p. 87, pl. 7. f. 16 (1864); Leech, A. M. N. H. (6) XIX. p. 675; Prout, Seitz, Macrolep, IV. p. 202, pl. 5 h.

Scotosia lucicolens Butl. Ill. Het. B. M. II. p. 54, pl. 37. f. 10 (1878).

A female taken by me at Kosugitani, Yakushima, July 14, 1918.

Local distribution. Honshiu; Kiushiu.

General distribusion. Japan; China; Siberia; Formosa.

Subfam. SCOPULINÆ.

Scopula steganioides.

Acidalia steganioides But. Ill. Het. B. M. II. p. 51, pl. 37. f. 8 (1878); Leech, A. M. N. H. (6) XX. p. 103; Prout, Seitz, Macrolep. IV. p. 54, pl. 4 m.

Acidalia steganioides ab. *unicolor* Prout, Seitz, Macrolep. IV. p. 55 (1913).

A female taken by me at Miyanoura, Yakushima, July 12, 1918, and a male by Miyake, August 1909.

Local distribution. Honshiu, Kiushiu.

General distribution. Japan; Corea.

Scopula lactea.

Lycauges lactea Butl. A. M. N. H. (5) IV. p. 373 (1879); Prout, Seitz, Macrolep. IV. p. 54, pl. 3 g.

Acidalia emissaria Hmpsn. (part) Moths Ind. III. p. 435 (1895), nec Wlk.

A male and a female taken by me at Noma, Tanegashima, June 10 and 11, 1919.

Local distribution. Honshiu, Kiushiu.

General distribution. Japan; China.

Scopula ignobilis.

Craspedia ignobilis Warren, Novit. Zool. VII. p. 22 (1901); Wileman, Trans. Ent. Soc. 1911, p. 334; Prout, Seitz, Macrolep. IV. p. 60, pl. 4 m.
Acidalia ignobilis subsp. *humilis* Prout. Seitz, Macrolep. IV. p. 61. (1913).

A male and a female taken by me at Kosugitani, Yakushima, July 14, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China.

Scopula satsumaria.

Acidalia satsumaria Leech, A. M. N. H. (6) XX. p. 91 (1897); Prout, Seitz, Macrolep. IV. p. 78, pl. 5 e.

A male taken by me at Kusukawa, Yakushima, July 20, 1918. In the specimen the terminal black dots of both wings are almost entirely absent.

Local distribution. Kiushiu.

Habitat. Japan.

Scopula hanna.

Acidalia hanna Butl. A. M. N. H. (5) I. p. 401 (1878); Ill. Het. B. M. III. p. 40, pl. 50. f. 11; Leech, A. M. N. H. (6) XX. p. 101; Prout, Seitz, Macrolep. IV. p. 75, pl. 3 m.

A male specimen.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea.

Scopula apicipunctata.

Acidata apicipunctata Christ. Bull. Mosc. II. p. 54 (1880); Staud. Cat. pal. p. 275; Prout, Seitz, Macrolep. IV. p. 70, pl. 5 b.
Acidalia arenaria Leech, A. M. N. H. (6) XX. p. 95 (1897).

A female taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Kiushiu; Honshiu.

General distribution. Japan Corea; China; Siberia.

Scopula coniaria.

Acidalia pulveraria Leech, A. M. N. H. (6) XX. p. 98 (1897).

Acidalia coniaria Prout, Seitz, Mocrolep. IV. p. 72, pl. 3 m (1913)

A male and a female taken by me at Miyanoura, Yakushima and Nishinoomote, Tanegashima, July 12 and 27, 1918.

Local distribution. Honshiu; Kiushiu.

Habitat. Japan.

Scopula plumbearia.

Acidalia plumbearia Leech, Entom. Suppl. p. 55 (May 1891); A.. M. N. H. (6) XX. p. 100; Prout, Seitz, Macrolep. IV. p. 73, pl. 5 f.

A male taken by me at Nishinoomote, Tanegashima, July 26, 1918.

Local distribution. Kiushiu.

Habitat. Japan.

Timandra amata.

Geometra amata Linn. Syst. Nat. 10 ed. p. 524 (1758); Prout, Seitz, Macrolep. IV. p. 47, pl. 5 f.

Calothysania amataria Hübn. Verz. Schmett. p. 31.

Timandra amataria Dup. Lep. VII. pl. 148. f. 3; Hmpsn. Moths Ind. III. p. 458; Leech, A. M. N. H. (6) XIX. p. 109.

Timandra comptaria Wlk. Cat. XXVI. p. 1615; Butl. Ill. Het. B. M. III. pl. 61. f. 2.

Timandra amata ab. *suffumata* Prout. Seitz, Macrolep. IV. p. 48 (1913).

Timandra amata ab. *bipartita* Prout, Seitz, Macrolep. IV. p. 48 (1913).

A female of the *comptaria* form taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Hokkaido; Honshiu; Shikoku: Kiushiu.

General distribution. Japan; Siberia; China; India; Europe.

Subfam. GEOMETRINÆ.

Chloromachia infracta.

Thalassodes infracta Wileman, Trans. Ent. Soc. 1911, p. 342, pl. 30. f. 16, ♂; Prout, Seitz, Macrelop. IV. p. 18.

♀. Palpi with the third joint long. Forewings with a larger brown-tinged white patch at anal angle. Hindwings without green tinge on the broad brown-tinged white terminal area. Expanse 32 mm.

A female taken by me at Kusukawa, Yakushima, July 20, 1918.

Local distribution. Honshiu; Kiushiu (Yakushima).

Habitat. Japan.

Subfam. ALETINÆ.

Doratoptera (?) *virescens.*

(Pl. III. fig. 4)

♀. Body rather robust. Head and thorax hairy. Palpi porrect, clothed with long hair, and not reaching beyond frons, proboscis well developed. Antennæ minutely ciliated; vertex of head with a high erect crest of hair. Legs rather stout, hind tibiæ with two pairs of spurs. Forewings with the apex acute but not so extremely produced as in *D. nicevillei* Hmpsn.; anal angle rounded off; venation as in *D. nicevillei.* Hindwings with the apex arched and pointed at end of vein 7; venation as in *D. nicevillei.*

Palpi, frons, and the face of crest of vertex brownish orange. Thorax and forewings greenish yellow, the former streaked with orange at middle. Wings satiny texture. Hindwings white faintly tinger with yellowish. Fore legs brownish fulvous with the terminal sagments of tarsi white. Abdomen whitish.

Expanse 54 mm.

Received two females from Miyeda, taken at Kosugitani, Yakushima, June 1918. I also met with a female in Tanegashima.

Fam. **Uraniadæ.**

Subfam. Epiplemінæ.

Epiplema moza.

Erosia moza Butl. A. M. N. H. (5) I. p. 402 (1868); Ill. Het. B. M. III. p. 42, pl. 51. f. 7; Leech, A. M. N. H. (6) XIX. p. 184.

A male taken by me at Nishinoomote, Tanegashima, July 23, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; India.

Epiplema cretacea.

Erosia cretacea Butl. Trans. Ent; Soc. 1881, p. 414; Leech, A. M. N. H. (6) XIX. p- 185.

Two females taken by me at Noma, Tanegashima, June 15 and 16, 1919.

Local distribution. Honshiu; Kiushiu.

Habitat. Japan.

Fam. **Heterogeneidæ.**

Miresa inornata.

Miresa inornata Wlk. Cat. V. p, 1125♀ (1855; Butl. Cist. Ent. III. p. 120♂ (1885); Hmpsn. Moths Ind. I. p. 386; Leech, Trans. Ent. Soc. 1899, p. 104; Seitz, Seitz, Macrolep. II, p. 344.

Two males and a female taken by me at Kosugitani, Yakushima, July 14, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; China; India; Siberia.

Microleon longipaplis.

Microleon longipalpis Butl. Cist. Ent. III. p. 121 (1885); Leech, Trans. Ent. Soc. 1899, p. 107; Seitz, Seitz, Macrolep. II. p. 341, pl. 50 a.

A male taken by me at Kosugitani, Yakushima, July 15, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea.

Fam. **Danaidæ.**

Subfam. EUPLŒINÆ.

Euplœa tytia.

Euplœa tytia Gray, Lep. Ins, Nepal. p. 2, pl. 9. f. 2 (1833–1846); Moore, Lep. Ind. I. p. 61, pl. 15. f. 1, 1a–1c; Pryer, Rhop. Nihon. p. 29, pl. 8. f. 9; Leech, Butl. Chin. Jap. Cor. I. p. I; Fritze, Faun. Liu-Kiu-Ins. p. 41; Miyake, Ann. Zool. Jap. VI. p. 64; Seitz, Seitz, Macrolep. I. p. 77, pl. 28 e.

Danais sita Koll. Hüg. Kasch. IV. p. 424, pl. 6 (1844).

Caduga niphonica Moore, P. Z. S. 1883, p. 249.

Caduga loochooana Moore, P. Z. S. 1883, p. 250.

The *niphonica* form was found commonly on the summit of Mt. Miyanoura, Yakushima, in July 1918.

Local distribution. Hokkaido; Honshiu; Shikoku. Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; Malay; India.

Subfam. MANIOLINÆ.

Ypthima argus.

Ypthima argus Butl. Journ. Linn. Soc. Zool. IX. p. 56 (1866); Elw. et Edw. Trans. Ent. Soc. 1893, p. 35, pl. 2. f. 28; Leech, Butl. Chin. Jap. Cor. II. p. 649; Fruhst. Seitz, Macrolep. IX. p. 290; Niré, Dobutsu-zas. 1917, Suppl. p. 13.

Ypthima evanescens Butl. A. M. N. H. (5) VII. p. 134. (1881).

Ypthima baldus Pryer (nec Fabr.), Rhop. Nihon. p. 30, pl. 9. f. 3 (1889); Seitz, Seitz, Macrolep. I. p. 91.

Ypthima philomera Leech (nec Johans.), Butl. Chin. Jap. Cor. I. p. 90 (1892).

Not uncommon. They are all *argus* form.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; Siberia; China.

Neope goschkevitschii.

(Pl. III. fig. 5.)

Lasiommata goschkevitschii Mén. Cat. Mus. Peter. II. p. 121, pl. 10. f. 4 (1855); Leech, Butl. Chin. Jap. Cor. I. p. 52; Seitz, Seitz, Macrolep. I. p. 90, pl. 32 c; Wileman, Philip. Journ. Scien. IX. p. 258, pl. 2. figs. 7–11, larva; Niré, Dobutsu-zas. 1917, Suppl. p. 24.

Lasiommata gaschkevitschii Feld. (Nec Mén.), Wien. Ent. Mon. VI. p. 28 (1862); Pryer, Rhop. Nihon. p. 32, pl. 9. f. 11.

Neope gaschkewitschii Matsumura (nec Mén.), Cat. Ins. Jap. I. p. 14 (1905).

Neope japonica Butl. A. M. N. H. (5) VII. p. 133 (1887).

On the summit of Mt. Miyanoura I met with a good deal of the dark form of this species, which were at first considered as a distinct species. The yellow colour on the underside of the wings, especially of the hindwings, is entirely replaced by white and fuscous.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

Habitat. Japan.

Melanitis phedisma.

Papilio phedisma Cram. Pap. Exot. IV. pl. 292; Fruhst. Seitz, Mecrolep. IX. p. 363.

Melanitis bela Moore, Cat. Lep. Mus. E.I·C. I. p. 223 (1857).

Melanitis varaha Moore, Cat. Lep. Mus. E. I. C. I. p. 224 (1857).

Melanitis gokala Moore, Cat. Lep. Mus. E. I. C. I. p. 224 (1857).

Melanitis aswa Moore, P. Z. S. 1865, p. 769.

Melanitis tambra Moore, Lep. Ceyl. I. p. 15, pl. 9. figs. 2, 2a–2c, ♂♀, larva and pupa (1880).

Melanitis aculeata Hmpsn. J, A. S. B. 1888, p. 351.

Melanitis ampa Swinhoe, A. M. N. H. (6) V. p. 353 (1890).

Melanitis bethami Nicév. P. Z. S. 1887, p. 451.

Lethe sicelis Miyaj. (part). Dobutsu-zas. 1899, p. 330, p. 330, pl. 17. f. 2.

Melanitis aswa var. *tristis* Miyake (nec Feld), Ann. Zool. Jap. 1907, p. 67.

Metanitis muskata, patra, autumnalis, ganapati, aswina, polishana, sumati, linga. Fruhst. Ent. Zeit. Stuttg. 1908, pp. 80–82.

Melanitis galkissa, enganica, fulvinotaia, nyaga, nuwara, Fruhst. Seitz, Macrolep. IX. p. 364.

Three males and a female taken by MIYAKE. I also met with this species in Tanegashima.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea; India.

Melanitis leda.

Nymphalis leda Linn. Syst. Nat. 12 ed. p. 773 (1767 ; Pryer, Phop. Nihon. p. 30, pl. 8, f. 8; Leech, Butt. Chin. Jap. Cor. I. p. 106, pl. 12. figs. 2, 5; Fritze, Faun. Liu-Kiu-Ins. p. 51; Seitz, Macrolep. I. p. 89, pl. 32 e.

Melanitis determinata Butl. Ent. Mon. Mag. XXI. p. 246 (1855).

Papilio ismene Cram. Pap. Exot. I. pl. 26. figs. A. S. (1775).

Papilio mycena Cram. Pap. Exot. IV. pl. 291. fig. F (1782).

Miyake took a female in Tanegashima, August 1909. Recorded also by Iwata.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Formosa; Corea; India; Africa.

Mycalesis gotama.

Mycalesis gotama Moore, Cat. Lep. Mus. E. I. C. I. p. 232. (1857); Pryer Rhop. Nihon. p. 30, pl. 9. f. 1; Leech, Butl. Chin. Jap. Cor. I. p. 14, pl. 2. f. 5; Seitz, Seitz, Macrolep. I. p. 81, pl. 29 c; Wileman, Philip. Journ. Scien. IX. p. 264, pl. 3. figs. 8–16, larva.

Mycalesis borealis Feld. Reise Nov. Lep. p. 500 (1867).

Mycalesis madjicosa Butl. Cat. Satyr. B. M. p. 137, pl. 3. f. 10 (1868).

Mycalesis perdiccas Fritze (nec Hew.), Faun. Liu-Kiu-Ins. p. 52 (1892).

Mycalesis fulginia seriphus Fruhst. Seitz, Macrolep. IX. p. 348 (1911).

4 males and a female of the typical form.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Corea; China.

Subfam. DANAINÆ.

Dichorragia nesimachus.

Adolias nesimachus Boisd. Cuv. Règne Anim. Ins. II. pl. 139. f. 1 (1836); Pryer, Rhop. Nihon. p. 22, pl. 5. f. 10; Leech, Butl. Chin. Jap. Cor. I. p. 132; Fritze, Faun. Liu-Kiu-Ins. p. 48; Miyajima, Nihon-chor. p. 138 pl. 14. f. 8; Stichel, Seitz, Macrolep. I. p. 168, pl. 60 b.

Dichoragia nesseus nesiotes, formosanus, peisistratus, pelurius, harpalycus, pe˙sandrus, *mannus,* etc. Fruhst. Seitz, Macrolep. IX. p. 696.

Two males taken by MIYAKE in Yakushima. I also met with it near Nishinoomote, Tanegashima, July 1918.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; Malay; India.

Cyrestis thyodamas.

Cyrestis thyodamas Boisd. Cuvier's Règ. Anim. Ins. II. pl. 138. f. 4 (1836); Pryer, Rhop. p. 23, pl. 5. f. 14; Leech, Butl. Chin. Jap. Cor. I. p. 248; Fritze, Faun. Liu-Kiu-Ins. p. 46; Miyajima, Nihon-Chor. p. 116, pl. 9. f. 9; Stichel, Seitz, Macrolep. I. p. 173, pl. 61 e.

Amathusia ganesha Koll. Hüg. Kasch. IV. pt. 2 430, pl. 7. figs. 3, 4 (1848)

Cyrestis afgana, nobilior, chinensis Martin, Ins. XVI. pp. 86–87.

Cyrestis mabella, formosana Fruhst. Soc. Ent. XIII. p. 74 (1898).

Very common. All are of the *mabella* form.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; India.

Neptis hylas.

Nymphalis hylas Linn. Syst. Nat. 10 ed. p. 486 (1758); Stichel, Seitz, Macrolep. I. p. 175; Nire, Dobutsu-zas. 1918, Suppl. p.

Liminitis eurynome Westwood, Donovan's Ins. Chin. 2nd ed. p. 66, pl, 38. f. 4 (1842).

Nepiis sangaica Moore, A. M. N. H. (4) XX. p. 47 (1877).

Neptis astola emodes, varmona Moore, P. Z. S. 1872, pp. 560–561.

Neptis kamarupa Moore, P. Z, S. 1874, p. 570.
Neptis andamana, nicobarica, disrupta Moore, P. Z. S. 1877, p. 586.
Neptis adara meetana Moore, P. Z. S. 1878, p. 830.
Neptis swinhœi Butl. P. Z. S. 1883, p. 145, pl. 24. f. 9.
Neptis intermedia Pryer, Cist. Ent. II. p. 231, pl. 4. f. 1 (1877).
Neptis aceris Pryer (nec Leyechin), Rhop. Nihon. p. 24, pl. 16. f. 1 (1888); Leech, Butt. Chin. Jap. Cor. I. p. 203; Miyajima, Nihon-chor. p. 127, pl. 13. f. 1.
Neptis yessonensis, passerculus, luculenta, acerides, bangkiva, symada, hageni, hatra etc. Fruhst. Seitz, Macrolep. IX. p. 601.

5 males taken by MIYAKE in Tanegashima.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Corea; Formosa; China; India.

Junonia orithya.

Nymphalis orithya Linn. Syst. Nat. 10 ed. p. 473 (1758); Leech, Butt. Chin. Jap. Cor. I. p. 279, pl. 25. figs. 8–10; Moore, Lep. Ceyl. I. p. 41, pl. 22. figs. 1, 1a, 1b ♂ ♀, larva and pupa; Fritze, Faun. Liu-Kiu-Ins. p. 45; Stichel, Seitz, Mrcrolep. I. p. 197, pl. 62 b, c; Niré, Dobutsu-zas. 1918, Suppl. p. 15.
Junonia orithyia Doubleday (nec Linn.), Gen. Diurn. Lep. I. p. 209 (1849).
Junonia isocratia Hübn. Verz. p. 34 (1816).
Junonia orythia Wallace (nec Linn.), P. Z. S. 1866, p. 359.
Junonia orishya formosana Matsumura, Dobutsu-zas. 1909, p. 393.

A male of the typical form taken by me at Nishinoomote, Tanegashima, July 2, 1918. Recorded also by IWATA.

Local distribution. Kiushiu (Kagoshima, Tanegashima, Yakushima).

General distribution. Japan; Loochoo; Formosa; China; Malay; India.

Junonia almana.

Nymphalis almana Linn. Syst. Nat. 10 ed. p. 472 (1758); Cram. Pap. Exot. 1. pl. 58. figs. F, G; Miyake, Ann. Zool. Jap. VI. p. 59; Stichel, Seitz, Macrolep. 1. p. 197, pl. 62 a; Niré, Dobutsu-zas. 1918, Suppl. p. 16.
Nymphalis asterie Linn. Syst. Nat. 10 ed. p. 472 (1758).

Several specimens of the *asterie* form taken by me in Tanegashima, July 1918. They frequent the flowers of *Phellopterus littoratis* which grow in a great numbers on the coast of that island.

Local distribution. Kiushiu (Tanegashima, Yakushima).

General distribution. Japan; Loochoo; Formosa; China; Malay; India.

Pyrameis cardui.

Nymphalis cardui Linn. Syst. Nat. 10 ed. p. 475; Moore, Lep. Ceyl. I. p. 50, pl. 27. figs. 1, 1 a; Pryer, Rhop. Nihon. p. 26, pl. 7. f. 2; Leech, Butt. Chin. Jap. Cor. I. p. 251; Stichel, Seitz, Macrolep. I. p. 199, pl. 62 d; Niré, Dobutsu-zas. 1918, Suppl. p. 14.

Pyrameis cardui japonica Stichel, Seitz, Macrolep. 1. p. 200, pl. 62 d (1909).

Recorded by IWATA.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushu.

General distribution. Cosmopolitan.

Vanessa canace.

Papilio canace Johans. Centur. Ins. p. 23 (1763); Moore, Lep. Ind. IV. p. 92, pl. 315. figs. 1, 1 a, ♂. ♀; Leech, Butt. Chin. Jap. Cor. I. p. 255; Miyajima, Nihon-chor. p. 113, pl. 10. f. 8; Stichel, Seitz, Macrolep. I. 206.

Vanessa no-japonica Siebold, Hist. Nat. Jap. p. 16 (1824).

Vanessa glanconia Moore, P. Z. S. 1879, p. 137.

Vanessa canace ishima Fruhst. Stett. Ent. Zeit. p. 416 (1894).

Vanessa canacc drilon Fruhst. Ent. Wochenb. p, 41 (1908).

Vanessa charonides Stichel, Seitz, Macrolep. I. p. 206, pl. 63 c (1906).

Vanessa canace siphnos Fruhst. Seitz, Macrolep. IX. p. 527 (1912).

A female of the *no-japonica* form by HABUTSU in Yakushima, August 1910. Recorded also by IWATA.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Corea; Formosa; China; India.

Argynnis nerippe.

Argynnis nerippe Feld. Wien. Ent. Mon. VI. p. 24 (1862); Pryer, Rhop.

Nihon. p. 28, pl. 8. f. 1 A, B; Leech, Butt. Chin. Jap. Cor. I. p. 234, pl. 22. figs. 7, 8; Seitz, Seitz, Macrolep. I. p. 239, pl. 69 f; Niré, Dobutsu-zas. 1918, Suppl. p. 6.

Argynnis coreana Butl. A. M. N. H. (5) IX. p. 15 (1882).

Argynnis chlorotis, nerippina, megalothymus Fruhst. Soc. Ent. XXII. p. 68 (1908).

Recorded by IWATA.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; China; Tibet; Siberia.

Argynnis sagana.

Argynnis sagana Doubleday, Gen. Diurn. Lep. pl. 24. f. 1 (1847); Pryer, Rhop. Nihon. p. 28, pl. 8. f. 3, ♂, pl. 10. fig. 24, ♀; Leech, Butt. Chin. Jap. Cor. I. p. 241; Seitz, Seitz, Macrolep. I. p. 240, pl. 71 b; Niré, Dobutsu-zas. 1918, Suppl. p. 18.

Damora paulina Nord. Bull. Mosc. II. p. 440, pl. 11. figs. 1, 2 (1851).

Argynnis sagana liana, ilona Fruhst. Soc. Ent. XXII. p. 67 (1907).

Recorded by IWATA.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; China; Siberia.

Argynnis hyperbius.

Papilio hyperbius Johansen, Amoen. Acad. VI. p. 408, ♀ (1764); Niré, Dobutsu-zas. 1918, Suppl. p. 5.

Nymphalis niphe Linn. Syst. Nat. 12 ed. p. 785 (1767).

Acidalia taprabana Moore, Lep. Ind. IV. p. 237 (1899–1900).

Argynnis niphe var. *castetsi* Oberth. Bull. Soc. Ent. Fr. 1889, p. 235.

Very common.

Local distribution. Honshiu, Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; Java; Sumatra; India.

Fam. **Asciadae.**

Hebomoia glaucippe.

Danaus glaucippe Linn. Syst. Nat. 10 ed. p. 469 (1758); Moore, Lep. Ceyl.

I. p. 127, pl. 49. figs. 1, 1 a, 1 b, ♂ ♀, larva and pupa; Fritze, Liu-Kiu-Ins. p. 38; Fruhst. Seitz, Macrolep. IX. p. 175.

Hebomoia australis Butl. A. M. N. H. (7) 1. p. 260 (1898).

Hebomoia glaucippe liukiuensis Fruhst. Berl. Ent. Zeitschr. p. 172 (1898).

Hekomoia glaucippe conspergata Fruhst. Deut. Ent. Zeit. Iris, XXI. p. 92 (1907).

Hebomoia glaucippe formosana Fruhst. Ent. Zeitschr. Stuttg. p. 102 (1908).

Hebomoia glaucippe cinica, aturia, anaxandra, erinna Fruhst. Seitz, Macrolep. IX. p. 175-176 (1910).

Not uncommon in Tanegashima and Yakushima from July to August. They all belong to the *liukiuensis* form.

Local distribution. Kiushiu (Yakushima, Tanegashima).

General distribution. Japan, Loochoo; Formosa; China; Malay; India.

Pieris rapae.

Danaus rapae Linn. Syst. Nat. 10 ed. p. 468 (1758); Pryer, Rhop. Nihon. p. 6, pl. 3. f. 6; Leech, Butt. Chin. Jap. Cor. II. p. 456; Röber, Seitz, Macrolep. I. p. 46, pl. 20 c; Niré, Dobutsu-zas. 1916, Suppl. p. 63.

Pieris brassicae var. *crucivora* Boisd. Gén. p. 522 (1836).

Pieris rapae var. *orientalis* Oberth. Etud. Ent. V. p. 13 (1880).

Pieris rapae var. *mandschrica* Speyer, Stett. Ent. Zeit. 1882, p. 379.

Pieris rapae dubiosa, flavescens, viluiensis Röber, Seitz, Macrolep. 1. p. 46 (1907).

Very common.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; Saghalin; China; Siberia; Europe.

Pieris melete.

Pieris melete Mén. Cat. Mus. Petr. 11. p. 113, pl. 10. figs. 1, 2 (1857); Leech, Butt. Chin. Jap. Cor. II. p. 448; Röber, Seitz, Macrolep. I. p. 47, pl. 21 b; Niré, Dobutsu-zas. 1916, Suppl. p. 62.

Pieris aglaope Motsch. Etud Ent. IX. p. 28 (1860).

Pieris napi Pryer (nec Linn.), Rhop. Nibon. p. 6, pl. 3. f. 8 b (1886).

Pieris rapae var. *mandarina* Leech, Butt. Chin. Jap. Cor. II. p. 451.

Synchloe megamera Butl. Cist. Ent. I. p. 173 (1873).

Ganoris dulcinea Butl. A. M. N. H. (5) IX. p. 18 (1882).

Pieris melete massiva, juba Fruhst. Seitz, Macrolep. IX. p. 140 (1910).

Recorded by IWATA.

Local distribution, Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; Saghlin: Siberia; China; India; Europe.

Anthocharis scolymus.

Anthocharis scolymus Butl. Journ. Soc. Linn. Zool. IX. p. 52 (1866); Pryer, Rhop. Nihon. p. 6, pl. 3. figs. 4 a, b; Leech, Butt. Chin. Jap. Cor. II. p. 479; Röber, Seitz, Macrolep. 1. p. 55, pl. 23 a; Niré, Dobutsu-zas. 1917, Suppl. p. 4.

Anthocharis thunbergii de l'Orza, Lep. Jap. p. 14 (1869).

Midea scolymus ab. *virgo* Röber, Seitz, Macrolep. I. p. 55 (1907).

Recorded by IWATA.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; China.

Eurema laeta.

Terias laeta Boisd. Spec. Gén. Lép. p. 674 (1836); Pryer, Rhop. Nihon. p. 10, pl. 2. f. 10; Leech, Butt. Chin. Jap. Cor. II. p. 425; Röber. Seitz, Macrolep. I. p. 58, pl. 23 e; Eruhst. Seitz. Macrolep. IX. p. 166, pl. 73 d; Niré, Dobutsu-zas, 1917, Suppl. p. 9.

Terias bethesba Jans. Cist. Ent. II. p. 272 (1878).

Terias subfervens Butl. A. M. N. H. (5) XI. p. 258 (1883).

Terias biformis Pryer, Rhop. Nihon. p. 21 (1888).

Seven males of the *bethesba* form taken by MIYAKE. Recorded also by IWATA.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea; China; Malay; India.

Eurema hecabe.

Danaus hecabe Linn. Syst. Nat. 10 ed. p. 470 (1758); Leech, Butt. Chin. Jap. Cor. II. p. 428; Fritze, Faun. Liu-Kiu-Ins. p. 35. figs. 9-11; Röber,

Seitz, Macrolep. I. p. 59, pl. 23 f; Niré, Dobutsu-zas. 1917, Suppl. p. 8.
Terias multiformis Pryer, Trans. Ent. Soc. p. 489 (1882).
Terias mandarina de l'Orza, Jap. p. 18 (1869).
Terias mariesii Butl. Trans. Ent. Soc. 1880, p. 198, pl. 7. figs. 1–7.
Terias hybrida Butl. Trans. Ent. Soc. 1880, p. 199, pl. 6. f. 7.
Terias connexiva Butl. Trans. Ent. Soc. 1880, p. 199, pl. 6. f. 12.
Terias anemone Feld. Wien. Ent. Mon. VI. p. 23 (1862).
Terias hobsoni Butl. P. Z. S. 1880, p. 668.
Terias unduligera Butl. P. Z. S. 1880, p. 668.

Very common.

Local distribution. Honshu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Malay; India.

Colias hyale.

Danaus hyale Linn. Syst. Nat. 10 ed. p. 469 (1758); Pryer, Rhop. Nihon. p. 8, pl. 2. f. 4 B; Leech, Butt. Chin. Jap. Cor. II. p. 431, pl. 34. figs. 3, 4, 6, 10, 11, 12, 14; Fritze, Faun. Liu-Kiu-Ins. p. 38; Miyake, Ann. Zool. Jap. VI. p. 25; Röber, Seitz, Macrolep. I. p. 65, pl. 25 g; Niré, Dobutsu-zas. 1917, Suppl. p. 1.
Colias poliographus Motsch. Etud. Ent. IX. p. 29 (1860).
Colias pallens Butl. Journ. Linn. Soc. Zool. IX. p. 52 (1866).
Colias simoda de l'Orza, Lep. Jap. p. 16 (1869).
Colias elwesii Butl. A. M. N. H. (5) VII. p. 138 (1881).
Colias subaurata Butl. A. M. N. H. (5) VII. p. 138 (1881).
Colias hyale ab. *emarginata* Röber, Seitz, Macrolep. I. p. 65 (1907).

Very common.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loohoo; Formosa; Corea; China; Siberia; Europe.

Fam. **Cupidinidae.**

Arhopala japonica.

Amblypodia japonica Murray, Ent. Mon. Mag. XI. p. 170 (1875); Pryer,

Rhop. Nihon. p. 11, pl. 2. f. 14; Leech, Butt. Chin. Jap. Cor. II. p. 344, pl. 30. f. 14; Miyajima, Nihon-Chor. p. 173, pl. 19. f. 6; Seitz, Seitz, Macrolep. I. p. 274, pl. 75 b.

Arhopala japonica var. *horishana* Matsumura, Ent. Zeitschr. Stuttg. XXII. p. 221 (1910).

Five males and a female taken by MIYAKE in Tanegashima. Recorded also by IWATA.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea.

Arhopala bazalus.

Amblypodia bazalus Hew. Cat. Lyc. B. M. p. 8, pl. 4. figs. 37, 38 (1862); Moore, Journ. Asiat. Soc. Bomb. LIII. p. 39; Niré, Dobutsu-zas, 1919, Suppl. p. 22.

Amblypodia turbata Butl. P. Z. S. 1881, p. 855; Pryer, Rhop. Nihon. p. 11, pl. 11. f. 16; Leech, Butt. Chin. Jap. Cor. II. p. 345; Miyajima, Nihon-Chor. p. 173, pl. 19. figs. 4, 5; Seitz, Seitz, Macrolep. I. p. 275.

Satadra teesta Nicév. Journ. Asiat. Soc. Beng. LV. p. 253, pl. 11. f. 3 (1886).

Two males taken by MIYAKE. Recorded also by IWATA.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; India.

Curetis acuta.

Curetis acuta Moore, A. M. N. H. (4) XX. p. 50 (1877); Pryer, Rhop. Nihon. p. 11, pl. 4. figs. 1, 2; Leech, Butt. Chin. Jap. Cor. II. p. 349; Miyajima, Nihon-Chor. p. 176, pl. 19. figs. 9, 10; Seitz, Seitz, Macrolep. I. p. 276.

Anops phaedrus de l'Orza, Lep. Jap. p. 22 (1869).

Curetis truncata Moore, A. M. N. H. (4) XX. p. 50 (1877).

Curetis paracuta Nicév. Journ. Bomb. Nat, Hist. Soc. XIV, p. 248 (1901); Wileman, Philip. Journ. Scien. X. p. 297, pl. 2. figs. 18–22.

Curetis acuta japonica, tsushimana Fruhst. Stett. Ent. Zeit. 1908, pp. 56, 57.

Curetis acuta formosana Fruhst. Ent. Zeitschr. Stuttg. XXII. p. 46 (1908).

Curetis acuta lucifuga Fruhst. Soc. Ent. XXIV. p. 12 (1909).

A male of the *paracuta* form taken by me at Nishinoomote, Tanegashima, July 23, 1918. Occurs also in Yakushima. Recorded by IWATA.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; China; India.

Polyommatus boeticus.

Plebejus boeticus Linn. Syst. Nat. 12 ed. 789 (1767); Moore, Lep. Ceyl. I. p. 93; Distant, Rhop. Malay. p. 214, fig. 64, p. 320, pl. 20. figs. 1, 8; Leech, Butt. Chin. Jap. Cor. II, p. 327; Miyajima, Nipon-Chor. p. 171, pl. 19, f. 3; Seitz, Seitz, Macrolep. I. p. 291, pl. 77 h.

Lycaena boetica Lang, Butt. Eur. p. 99, pl. 22, f. 2 (1884).

A female taken by me at Noma, Tanegashima, June 12, 1919. Recorded also by IWATA.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; Philippines; Malay; India; Africa; Australia; Europe.

Nacaduva atrata.

Lycaena atrata Horsfield, Cat. Lep. Mus. E. I. C. p. 78 (1828); Moore, Lep. Ceyl. I. p. 89; Davidson, Bell and Atkinson, Journ. Bom. Nat. Hist. Soc. p. 376, pl. 4 figs. 2, 2 a, larva and pupa; Bingham, Butt. Ind. II. p. 388.

Lycaena kurva Moore, Cat. Lep. Mus. E. I. C. 1. p. 22 (1857).

Lampides prominens Moore, A. M. N. H. (4) XX. p, 341 (1877).

A male specimen taken by MIYAKE in Yakushima. Recorded also by IWATA as common in this district.

Local distribution. Kiushiu (Yakushima and Tanegashima).

General distribution. Japan; Loochoo; Formosa; Malay; India.

Zizera maha.

Lycaena maha Koll. Hüg. Kasch. IV. p. 422 (1848); Leech, Butt, Chin. Jap. Cor. II, p. 325; Miyajima, Nihon-Chor. p. 168, pl. 18, f. 13; Seitz, Seitz, Macrolep. I. p. 295, pl. 79 c.

Lycaena argia Mén. Cat. Mus. Petr. II, p. 125, pl. 10. f. 7 (1857).

Polyommatus chandala Moore, P. Z. S. 1865, p. 504, pl. 31, f. 5.
Lycaena japonica Murray, Ent. Mon. Mag. XI. p. 167 (1874).
Lycaena diluta Feld. Nov. Reise, II, p. 280, pl. 35. figs. 12, 13 (1865).
Lycaena squalida Butl. Trans. Ent. Soc. 1879, p. 4.
Lycaena alope Fenton, P. Z. S. 1881, p. 351.
Zizera ossa Swinhoe, P. Z. S. 1885, p. 132, pl. 9. figs. 11, 12.
Lycaena opalina Pouj. Ann. Soc. Ent. Fr. 1885, p. 143.
Lycaena marginata Pouj. Ann. Soc. Ent. Fr. 1885, p. 151.

Very common. All are the *argia* form.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea; China; India.

Everes argiades.

Papilio argiades Pallas, Reise, 1. App. p. 472 (1771); Elwes, P. Z. S. 1881, p. 887; Pryer, Rhop. Nihon. p. 17, pl. 4, figs. 29 a, b; Leech, Butt. Chin. Jap. Cor. II, p. 328. Miyajima, Nihon-Chor. p. 170, pl. 19. figs. 1, 2; Seitz, Seitz, Macrolep. I. p. 297, pl. 78 a.
Hespera parrhasius Fabr. Ent. Syst. III. p. 289 (1793).
Lycaena hellotia Méw. Cat. Mus. Petr. II. p. 124, pl. 10. f. 6 (1857).
Lycaena dipora Moore, P. Z. S. 1865, p. 506, pl. 31. f. 8.

Recorded by IWATA.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea; Siberia; China; India; Australia; Europe; N. America.

Cyaniris argiolus.

Plebejus argiolus Linn. Syst. Nat. 10 ed. p. 483 (1758); Pryer, Rhop. Nihon. p. 18, pl. 4. figs. 25 a, b; Leech, Butt. Chin. Jap. Cor. II. p. 320; Miyajima, Nihon-Chor. p. 167, pl. 18, f. 12; Seitz, Seitz, Macrolep. I. p. 322, pl. 83 g, h.
Lycaena coelestina Koll. Hüg. Kasch. IV. p. 423 (1848).
Lycaena ladon Mén. Cat. Lep. Mus. Petr. II. p. 124, pl. 10, f. 5 (1857).
Polyommatus kasmira Moore, P. Z. S. 1865, p. 503, pl. 31, f. 1.
Lycaena ladonides de l'Orza, Lep. Jap. p. 20 (1867).

Lycaena levetti Butl. A. M. N. H. (5) XI. p. 111 (1883).

Cyaniris huegelii Moore, P. Z. S. 1882, p. 244.

Two males and females taken by me on Mt. Miyanoura, Yakushima, July 18, 1918, and at Furuta, Tanegashima, June, 19, 1919. It seems that the species is very common on Mt. Miyanoura.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea; Siberia; India; Africa; Europe.

Taraka hamada.

Melitus hamada Druce, Cist. Ent. 1. p. 361 (1875); Pryer, Rhop. Nihon. p. 10, pl. 2. f. 12; Leech, Butt. Chin. Jap. Cor. II. p. 298; Miyajima, Nihon-Chor. p. 160, pl. 18. f. 1; Seitz, Seitz, Macrolep. I. p. 323, pl. 83 f, g.

Two males taken by MIYAKE in Tanegashima.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; China; Java; Malay; India.

Fam. **Plebejidae.**

Subfam. LIBYTHEINÆ.

Libythea celtis.

Papilio celtis Fuessly, Arch, Ins. pl. 8, figs. 1-3. (1782); Seitz, Seitz, Macrolep. I. p. 251, pl. 71 f.

Libythea lepida Moore, Cat. Mus. E. I. C. I. p. 240 (1857).

Libythea bepidoides Moore, Lep. Ind. V. p. 57, pl. 394. figs. 1, 1 a-1 c, ♂ (1901-1903).

Recorded by IWATA.

Local distribution. Hokkaido, Honshiu; Shikoku; Kiushiu.

General distribution. Japan; India; Asia Minor; Europe.

Fam. EQUITIDÆ.

Eques alcinous.

Papilio alcinous Klug, Neue Schmett. p. 1, pl. 1. figs. 1-4 (1836); Pryer, Rhop. Nihon. p. 4, pl. 3. f. 3; Leech, Butt. Chin. Jap. Cor. II. p. 539;

Seitz, Seitz, Macrolep. I. p. 9, pl. 2 a, b; Wileman, Philip. Journ. Scien. IX. p. 255, pl. 2. figs. 12–16, larva; Niré, Dobutsu-zas. 1916, Suppl. p. 54.

Papilio mencius Feld. Wien. Ent. Mon. VI. p. 22 (1862).

Papilio spathatus Butl. A. M. N. H. (5) VII. p. 139 (1881).

Papilio hæmatostictus Butl. A. M. N. H. (5) VII. p. 139 (1881).

Papilio alcinous loochooanus Rothsch. Novit. Zool. II. p. 271 (1895).

Papilio alcinous mansonensis Fruhst. Soc. Ent. XVI. p. 113 (1901).

Papilio alcinous nagasaki Fruhst. Soc. Ent. XXI. p. 74 (1906).

Papilio plutonius Miyake (nec Oberth.), Dobutsu-zas. 1906, p. 148, p, 148, f. 5, pl. 4. f. 13.

Papilio alcinous bradanus Fruhst. Ent. Zeitschr. Stuttg. XXII. p. 46 (1908).

Papilio ikusa Ehrman, Canad. Entom. XLI. p. 85 (1909).

Recorded by Iwata.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; China.

Eques protenor.

Papilio protenor Cram. Pap. Exot. I. p. 77 (1777); Leech, Butl. Chin. Jap. Cor. II. p. 545; Miyake, Dobutsu-zas. 1906, p. 78, pl. 1. f. 1.

Papilio demetrius Cram. Pap. Exot. IV. p. 196, pl. 385. figs. E, F (1782).

Papilio carpenteri Butl. A. M. N. H. (5) X. p. 318 (1882).

Papilio demetrius liukiuensis Fruhst. Stett. Ent. Zeit. p. 407 (1898).

Papilio demetrius sitalkes Fruhst. Ent. Zeitschr. Stuttg. XXII. p. 46 (1908).

Papilio protenor amaura Jord. Seitz, Macrolep. IX. p. 75 (1909).

Papilio protenor taiwanus Matsumura, Dobutsu-zas. 1909, p. 390.

A male of the *demetrius* form taken by Miyake in Tanegashima. Recorded also by Iwata.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Malay; India.

Eques memnon.

Eques memnon Linn. Syst. Nat. 12 ed. p. 747 (1767); Pryer, Rhop. Nihon.

p. 4; Leech, Butl. Chin. Jap. Cor. II. p. 544; Fritze, Faun. Liu-Kiu-Ins. p. 28, figs. 3, 4; Niré, Dobutsu-zas. 1906, Suppl. p. 60.

Eques agenor Linn Syst. Nat. 10 ed. p. 460 (1758).

Papilio alcanor Cram. Pap. Exot. II. p. 107 (1777).

Papilio thunbergi Sieb. Hist. Nat. Jap. p. 16 (1824).

Papilio androgens Wall. (nec Cram.), P. Z. S. p. 356 (1866).

Papilio memnon pryeri Rothsch. Novit. Zool. II. p. 313 (1895).

Papilio memnon distantianus Rothsch. Novit. Zool. II. p. 320 (1895).

Papilio memnon heronus Fruhst. Soc. Ent. XVII. p. 73 (1902).

Papilio memnon titania Jordan, Seitz, Macrolep. IX. p. 73 (1909).

Very common in Yakushima and Tanegashima. All are *thunbergi* form.

Local distribution. Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; Philippines; Java; Borneo; Malay; India.

Eques bianor.

Papilio bianor Cram. Pap. Exot. II. p. 10, pl. 103. f. c. (1777); Pryer, Rhop. Nihon. p. 3; Leech, Butl. Chin. Jap. Cor. II. p. 527.

Papilio dehaanii Feld. Verh. Zool.-Bot. Ges. Wien, XIV. pp. 323, 371 (1864).

Papilio bianor var. *japonica* Butl. Journ. Linn. Soc. Zool. IX. p. 50 (1866).

Papilio alliacmon de l'Orza, Lep. Jap. p. 9 (1869).

Papilio maacki Pryer (nec Mén.), Rhop. Nihon. p. 3 (1886).

Papilio bianor okinawaensis Fruhst. Soc. Ent. No. 10 (1898).

Papilio bianor junia Jordan, Seitz, Macrolep. IX. p. 78 (1909).

Papilio bianor formosanus Rebel, Verh. Zool.-bot. Ges. Wien, LXI. p. 222 (1906).

Recorded by IWATA.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea; China; Siberia; Burma.

Eques helenus.

Eques helenus Linn. Syst. Nat. 12 ed. p. 745 (1767); Pryer, Rhop. Nihon. p.

4, pl. 2. f. 2 ; Leech, Butl. Chin. Jap. Cor. II. p. 548 ; Frite, Faun. LiuKiu-Ins. p. 27.

Papilio nicconicolens Butl. A. M. N. H. (5) VII. p. 139 (1881).

Papilio helenus semnus Fruhst. Entom. Wochenb. p. 38 (1908).

Papilio helenus orosius Fruhst. Entom. Wochenb. p. 38 (1908).

Papilio helenus fortunius Fruhst. Entom. Wochenb. p. 38 (1908).

MIYAKE took five males and three females in Tanegashima, August 1909, and I also took a male of the *nicconicolens* form at Kusukawa, Yakushima, July 21, 1918. Recorded by IWATA.

Local distribution. Honshiu ; Shikoku ; Kiushiu.

General distribution. Japan ; Loochoo ; Formosa ; China ; Philippines ; Malay ; India.

Eques xuthus.

Eques xuthus Linn. Syst. Nat. 12 ed. p. 751 (1767) ; Pryer, Rhop. Nihon. p-3, pl. 1. f. 2 b ; Leech, Butt. Chin. Cor. II. p. 514 ; Seitz, Seitz, Macro. lep. I. p. 11, pl. 6 a ; Niré, Dobutsu-zas. 1916, Supple. p. 51.

Papilio xuthulus Brem. Bull. Acad. Petr. III. p. 463 (1861) ; Lep. Ost-Sib. pl. 1. f. 2.

Papilio xuthus hoxinga Fruhst. Ent. Zeitschr. Stuttg. XXII. p. 46 (1908).

Six males and a female taken by MIYAKE in Tanegashima. Recorded also by IWATA.

Local distribution. Hokkaido ; Honshiu ; Shikoku ; Kiushiu.

General distribution. Japan ; Saghalin ; Corea ; Loochoo ; Formosa ; China ; Siberia ; Burma.

Eques machaon.

Eques machaon Linn. Syst. Nat. 10 ed. p. 462 (1758) ; Pryer, Rhop. Nihon. p. 3, pl. 1. f. 1 b ; Leech, Butl. China. Jap. Cor. II. p. 516 ; Seitz, Seitz, Macrolep. I. p. 12, pl. 6 c ; Niré, Dobutsu-zas. 1916, Suppl. p. 51.

Papilio sphyrus Hübn. Exot. Schmett. figs. 775, 776.

Papilio machaon asiatica Mén. Cat. Mus. Peter. Lép. I. p. 70 (1855).

Papilio hippocrates Feld. Verh. Zool.-bot. Ges. Wien, XIV. pp. 314, 362 (1864).

Papilio mikado Pagenst. (nec Leech), Verh. Ver. Heidelb. (2) I. p. 98 (1875).
Papilio ladakensis Moore, Journ. Asiat. Soc. Beng. 1884, p. 46.
Papilio sikkimensis Moore, Journ. Asiat. Soc. Beng. 1884, p. 47.
Papilio machaon var. *sacnolinensis* Matsumura, Journ. Coll. Agr. Sapporo, IV. p. 40 (1911).

A female taken by Miyake in Tanegashima, August 1909. Recorded also by Iwata.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Corea; Saghalin; China; India; Europe.

Eques sarpedon.

Eques sarpedon Linn. Syst. Nat. 12 ed. p. 747 (1767); Pryer, Rhop. Nihon. p. 5, pl. 1. f. 9; Leech, Butl. Chin. Jap. Car. II. p. 524; Fritze, Faun. Liu-Kiu-Ins. p. 30; Seitz, Seitz, Macrolep. I. p. 15, pl. 8 c; Wileman, Philip. Journ. Scien. IX. p. 252, pl. 9. figs. 6–8, larva.
Papilio sarpedon var. *semifasciatus* Hon. Ent. Nach. 1888, p. 161.
Papilio sarpedon connectens Fruhst. Soc. Ent. XXI. p. 73 (1906).
Papilio sarpedon nipponus, morius, sarpedonides Fruhst. Ent. Zeitschr. Stuttg. XXII, p. 46 (1908).
Papilio surusumi Matsumura, Ent. Zeitschr. Stuttg. XXIII. p. 209 (1910).

Very common in Tanegashima and Yakushima.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; Corea; China; Philippines; Java; Borneo; Sumatra; Malay; Amboina; New-Guinea.

Fam. **Erynnidæ.**

Rhopalocampta benjamini.

Thymele benjamini Guér. Deless. Souv. Voy. Inde, II. p. 79, pl. 22. figs. 2, 2 a (1843); Leech, Butl. Chin. Jap. Cor. II. p. 641; Miyajima, Nihon-Chor. p. 206, pl. 22. f. 11; Mabille, Seitz, Macrolep. I. p. 341, pl. 86 e.
Isemene benjamini var. *japonica* Murray, Ent. Mon. Mag. XII. p. 4 (1875).

Three males taken by Miyake. Recorded also by Iwata.

Local distribution. Hokkaido; Honshiu; Shikoku; Kiushiu.
General distribution. Japan; Loochoo; Formosa; China; India.

Parnara mathias.

Hesperia mathias Fabr. Ent. Syst. Suppl. p. 433 (1798); Moore, Lep. Ceyl. I. p. 168, pl. 70. figs. 1, 1 a; Distant, Rhop. Malay. p. 380, pl. 35. f. 10; Pryer, Rhop. Nihon. p. 33, pl. 10. f. 7; Leech, Butl. Chin. Jap. Cor. II. p. 606; Miyajima, Nihon-Chor. p. 201, pl. 32. f. 4; Mabille, Seitz, Macrolep. I. p. 349, pl. 88 f, g.

Very common.

Local distribution. Honshiu; Shikoku; Kiushiu.

General distribution. Japan; Loochoo; Formosa; China; Java; Malay; India; Aden.

Padraona flava.

Pamphila flava Murr. Ent. Mon. Mag. XII. p. 4 (1875); Pryer, Rhop. Nihon. p. 35, pl. 10. f. 17; Mabille, Seitz, Macrolep. I. p. 351.

Pamphila japonica Mabille, Ann. Soc. Ent. Belg. XXVIII (1883).

Padraona dara (part) Leech (nec Koll.), Butl. Chin. Jap. Cor. II. p. 596, pl. 40. figs. 13, 14 (1894).

A male taken by Miyake, August 1909. A male and a female also taken by me at Nishinoomote, Tanegashima, July 26, 1918.

Local distribution. Honshiu; Shikoku; Kiushiu.

Habitat. Japan.

Notocrypta curvifascia.

Plesioneura curvifascia Feld. Wien. Ent. Mon. VI. p. 29 (1862); Leech. Butl. Chin. Jap. Cor. II. p. 626, pl. 38, f. 1; Miyajima, Nihon-Chor. p, 205, p. 22. f. 9; Mabille, Seitz, Macrolep. I. p. 253, pl. 84 g.

Seven males and two females taken by Habutsu in Yakushima, August 1910. Recorded also by Iwata.

Local distribution. Kiushiu.

General distribution. Japan; Loochoo; Formosa; China.

Fam. **Zygænidæ.**

Subfam. CHALCOSIANÆ.

Procris tristis.

Procris tristis Brem. Lep. Ost-Sib. p. 97, pl. 8. f. 4 (1864); Leech, Trans. Ent. Soc. 1898, p. 331; Staud. Cat. Lep. pal. p. 390.

Procris esmeralda Butl. A. M. N. H. (4) XX. p. 394 (1877); Ill. Het. B. M. II. p. 4, pl. f. 8.

Procris pruni (part) Jord. Seitz, Macrolep. II. p. 6 (1912).

A male and two females taken by HABUTSU in Tanegashima, September 1910.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Siberia.

Heterusia ædea.

Heliconius ædea Linn. Syst. Nat. 10 ed. p. 757 (1758); Kirby, Cat. Het. I. p. 50; Hmpsn. Moths. Ind. 1. p. 262; Leech, Trans. Ent. Soc. 1898. p. 342; Jord. Seitz, Macrolep. II. p. 10, pl. 2 c.

I have seen two examples which were on wings near Nishinoomote, Tanegashima, June 1919, but failed to take them.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Loochoo; China; India.

Erasmia pulchella.

Erasmia pulchella Hope, Trans. Linn. Soc. Lond. XVII. p. 466, pl. 31. f. 5 (1840); Hmpsn. Moths Ind. I. p. 273; Fritze, Faun. Liu-Kiu-Ins. p. 64; Leech, Trans. Ent. Soc. 1898; p. 346; Jord. Seitz, Macrolep. II. p. 12.

Erasmia pulchella subsp. *chinensis* Jord. Seitz, Macrolep. II. p. 12, pl. 2 g (1912).

A male of the *chinensis* form taken by HABUTSU in Yakushima, August 1909 and there is another male from the same locality in my collection.

Local distribution. Kiushiu.

General distribution. Japan; Loochoo; China; India.

Fam. **Callidulidæ.**

Callidula formosana.

(Pl. III. fig. 6.)

Callidula formosana Wileman, Entom. 1910, p. 290.

A female taken by me in Yakushima, July 13, 1918 and another female by HABUTSU, August 1910. I have also seen this species which was on wings at Tanegashima, June 1919.

Local distribution. Kiushiu (Yakushima; Tanegashima).

General distribution. Japan; Formosa.

Fam. **Drepanidæ.**

Deroca phasma.

Deroca phasma Butl. A. M. N. H. (5) I. p. 442 (1878); Ill. Het. B. M. III. p. 49, pl. 53. f. 4; Nagano, Butt. Nawa Ent. Lab. II. p. 127, pl. 3. f. 15, pl. 9. figs. 16—20.

Deroca inconclusa (Part) Leech, Trans. Ent. Soc. 1898, p. 370; Strand, Seitz, Macrolep. II. p. 203, pl. 48 c.

A male taken by me on Mt. Miyanoura, Yakushima, July 18, 1918.

Local distribution. Honshiu; Kiushiu.

Habitat. Japan.

Fam. **Pyralidæ.**

Subfam. TINEINÆ.

Lamoria inostentalis.

Maraclea inostentalis Wlk. Cat. XXVII. p. 88 (1863); Leech, Trans. Ent. Soc. 1901, p. 387; Hmpsn. Novit. Zool. 1917. p. 51.

A female taken by HABUTSU in Yakushima, August 1910.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Formosa; Corea; China; Borneo; D'entrecasteaux Is.

Subfam. CRAMBINÆ.

Crambus diplogrammus.

Crambus diplogrammus Zell. Chil. et Cramb. p. 25 (1863); Leech, Trans. Ent. Soc. 1901, p. 388.

Two males taken by me on Mt. Miyanoura, Yakushima, July 16, 17, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China; Siberia.

Crambus argyrophorus.

Crambus argyrophorus Butl. Ill. Het. B. M. II. p. 61, pl. 40. f. 5 (1878); Hmpsn. Moths Ind. IV. p. 15; Leech, Trans. Ent. Soc. 1901, p. 392.

A male measuring in expanse 17 mm. taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution, Japan; China; India.

Ancylolomia chrysographella.

Chilo chrysographella Koll. Hüg. Kasch. IV. p. 494 (1844); Hmpsn. Moths Ind. IV. p. 33; Leech, Trans. Ent. Soc. 1901, p. 399.

Ancylolomia taprobanensis Zell. Hor. Ent. Ross. 1877, p. 25, pl. 1. f. 8; Moore, Lep. Ceyl. III. p. 381, pl. 184. figs. 2, 2 a.

Ancylolomia capensis Zell. Chil. et Cramb. p. 11.

Ancylolomia indica Feld. Reise Nov. Lep. pl. 137. f. 19 (1874).

Ancylolomia argentata Moore, Lep. Ceyl. III. p. 382, pl. 184. f. 3.

A male taken by me on Mt. Miyanoura, Yakushima, July 16, 1918.

Local distribution. Honshiu; Shikoku; Kiushiu; Hokkaido.

General distribution. Japan; Formosa; Corea; China; India; Africa.

Subfam. SIGINÆ.

Genus *Leechia.*

Leechia South, Trans. Ent. Soc. 1901, p. 400.

South states "neuration similar to that of *Niphopyralis* Hampson, but all the wings have veins 4, 5 stalked." The genus also characterized by the veins 7, 8, 9, 10 and 11 of the forewings being stalked.

Leechia sinuosalis.

Leechia sinuosalis South, Trans. Ent. Soc. 1901, p. 400, pl. 14. f. 15.

A male taken by me at Kosugitani, Yakushima, August 14, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China.

Patissa fulvosparsa.

Apurima fulvosparsa Butl. Trans. Ent. Soc. 1881, p. 591; Hmpsn. Moths Ind. IV. p. 44; Leech, Trans. Ent. Soc. 1901, p. 401.

Patissa tortualis Snellen, Tijd. Ent. XXXVI. p. 58, pl. 3. f. 3.

Two males and one female taken by me at Kita-tane, Tanegashima, June 10, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; Java; India.

Scirpophaga auriflua.

Scirpophaga auriflua Zell. Chil. et Cramb. p. 2 (1863); Hmpsn. Moths Ind. IV. p. 46; Leech, Trans. Ent. Soc. 1901, p. 401.

Spurima xanthogastrella Wlk. Cat. XXVII. p. 194 (1863).

A male taken by HABUTSU in Yakushima, August 1910.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China; Java; Borneo; India.

Subfam. ANERASTIANÆ.

Nephopteryx semirubella.

Phalœna semirubella Scop. Ent. Carn. p 245 (1763); Hmpsn. Moths Ind. IV. p. 84; Leech, Trans. Ent. Soc. 1901, p. 408.

Tinea carnella Linn. Syst. Nat. 12 ed. p. 887.

Tinea sanguinella Hübn. Samml. eur. Schmett. f. 65.

Salebria icterella Rag. Nouv. Phycit. p. 18 (1888).

Laodamia semirubella var *icterella* Rag. Rom. Mém. VII. p. 416, pl. 17. f. 4. (1893).

Common in Yakushima and Tanegashima.

Local distribution. Hokkaido; Honshiu; Kiushiu; Shikoku.

General distribution. Japan; Corea; China; Siberia; India; Europe.

Etiella zinckenella.

Phycis zinckenella Treit. Schmett. Eur. IX. 1. p. 201 (1832); Hmpsn. Moths Ind. IV. p. 108; Leech, Trans. Ent. Soc. 1901, p. 413.

Crambus sabulinus Butl. A. M. N. H. (5) IV. p. 456 (1879).

A female taken by me at Noma, Tanegashima, June 16, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Universal.

Subfam. ENDOTRICHINÆ.

Endotricha consocia.

Doththa consocia Butl. A. M. N. H. (5) IV. p. 452 (1879); Leech, Trans. Ent. Soc. 1901, p. 419.

A male taken by me in Yakushima, July 13, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution, Japan; China.

Endotricha theonalis.

Pyralis theonalis Wlk. Cat. XIX. p. 900 (1859); Leech, Trans. Ent. Soc. 1901, p. 417; Wileman, Trans. Ent. Soc. 1911, p. 368.

Pyralis(?) *thermusalis* Wlk. Cat. XIX. p. 912 (1859).
Zania unicalis Wlk. Cat. YXXIV. p. 1257 (1865).

A male taken by me at Nishinoomote, Tanegashima, July 28, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Formosa; China.

Subfam. PYRALINÆ.

Stemmatophora bicoloralis.

Endotricha bicoloralis Leech, Entom. XXII. p. 65, pl. 4. f. 17 (1889); Hmpsn. Moths Ind. IV. p. 157; Leech, Trans. Ent. Soc. 1901, p. 425.
Pyralis dulcicalalis Swinhoe, P. Z. S. 1889, p. 418; Hmpsn. Ill. Het. B. M. VIII. pl. 156. f. 13.

Very common in Yakushima.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; India.

Herculia pelasgalis.

Pyralis pelasgalis Wlk. Cat. XVII. p. 269 (1859); Leech, Trans. Ent. Soc. 1901, p. 427.

Three females taken by me at Miyanoura, Yakushima, and Kaminaka, Tanegashima, June 12, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China.

Bostra marginata.

Poaphila marginata Wlk. Cat. XXXIII.. p 991 (1865); Hmpsn. Moths Ind.. IV. p. 176; Leech, Trans. Ent. Soc. 1901, p. 431.
Paleca rufescens Butl. A. M. N. H. (5) IV. p. 354.
Pyralis assamica Moore, Lep. Atk. p. 205. pl. 7. f. 5.

A female taken by me at Nishinoomote, Tanegashima, July 26, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; Borneo; India.

Subfam. NYMPHULINÆ.

Cataclysta junctalis.

Cataclysta junctalis Hmpsn. Ill. Het. B. M. VIII. p. 140, pl. 155. f. 24 (1891); Trans. Ent. Soc. 1896, p. 148.

Cataclysta blandialis (part) Hmpsn. Moths Ind. IV. p. 197 (1896).

Four females and one male taken by me at Noma, Tanegashima, July 11, 15, 1919.

Hitherto unrecorded from Japan.

Local distribution. Kiushiu (Tanegashima).

General distribution. Japan; India.

Musotima acclaralis.

Isopteryx acclaralis Wlk. Cat. XVII. p. 403 (1859); Hmpsn. Ill. Het. B. M. IX. p. 180, pl. 174. f. 24; Moths Ind. IV. p. 200.

A female taken by me at Miyanoura, Yakushima, July 12, 1918, and another female taken at Noma, Tanegashima, June 15, 1919. Hitherto unrecorded from Japan.

Local distribution. Kiushiu (Yakushima, Tanegashima).

General distribution. Japan; India.

Bradina admixtalis.

Botys admixtalis Wlk. Cat. XVIII. p. 665 (1859); Hmpsn. Moths Ind. IV. p. 227; Leech, Trans. Ent. Soc. 1901, p. 440.

Botys panaeusalis Wlk. Cat. XIX. p. 998 (1859).

Pleonectusa labidalis Led. Wien. Ent. Mon. VII. p. 426 (1863).

Pleonectusa sodalis Led. Wien. Ent. Mon. VII. p. 426 (1863).

Botys leptogastralis Wlk. Cat. XXXIV. p. 1432.

Pleonectusa pallidalis Warr. A. M. N. H. (6) XVII. p. 147 (1896).

Very common throughout Tanegashima and Yakushima.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; India.

Diathrausta picata.

Danaga picata Butl. Ill. Het. B. M. VII. p. 94, pl. 134. f. 17 (1889); Hmpsn, Moths Ind. IV. p. 234 (1896); Leech, Trans. Ent. Soc. 1901, p. 442.

A male and a female taken by me at Noma, Tanegashima, July 15, 1919. The specimens have the postmedial line hardly traceable.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China; India.

Piletocera sodalis.

Desmia sodalis Leech, Entom. XXII. p. 71, pl. 4. f. 6 (1889); Hmpsn. Trans. Ent. Soc. 1896, p. 213; Leech, Trans. Ent. Soc. 1901, p. 442.

Five males and three females taken by me at Miyanoura and Kosugitani, Yakushima, July 12 and 14, 1918, and a male at Noma, Tanegashima, June 15, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China.

Piletocera aegimiusalis.

Desmia aegimiusalis Wlk. Cat. XIX. p. 929 (1859); Hmpsn. Moths Ind. IV. p. 236; Leech, Trans. Ent. Soc. 1901, p. 443.

A female taken by me at Miyanoura, Yakushima, July 12, 1918. In the specimen the collar and the base of abdomen are concolorous with the wings instead of being whitish. The expanse of wings measures 20 mm.

Local distribution. Kiushiu.

General distribution. Japan; Andamans; Borneo; Mysol; India.

Camptomastyx hisbonalis.

Botys hisbonalis Wlk. Cat. XVIII. p. 707 (1859); Hmpsn. Moths Ind. IV. p. 239; Leech, Trans. Ent. Soc. 1901, p. 443.

Botys pacalis Leech, Entom. XXII. p. 69, pl. 4. f. 15 (1889).

Diplotyla longiplpis Butl. Ill. Het. B. M. VII. p. 95, pl. 135. f. 4 (1889).

A female taken by me each in Yakushima and Tanegashima, July 14,

1918, and June 1919. The specimen taken in Yakushima with the vein 10 of forewings separated from 8 and 9.

Local distribution. Kiushiu.

General distribution. Japan; China; Borneo; Siam; India.

Subfam. AGROTERINÆ.

Zinckenia recurvalis.

Phalaena recurvalis Fabr. Syst. Ent. p. 407 (1775); Ent. Syst. III. (2) p. 237; Zell. Lep. Caffr. p. 55; Guen. Delt. et Pyr. p. 225, pl. 8. f. 5; Wlk. Cat. XVII. p. 396.

Phalaena Pyralis fascialis Cram. Pap. Exot. IV. pl. 398. f. 0 (1782).

Phalaena angustalis Fabr. Mant. Ins. p. 222 (1787).

Hymenia diffascialis Hübn. Verz. p. 361.

Hydrocampa albifascialis Boisd. Faun. Ent. Madag. Lep. p. 119, pl. 16. f. 1. (1834).

Two females taken by me at Miyanoura, Yakushima, and Nishinoomote, Tanegashima, July 12, 26, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Formosa; China; Malay; India; Australia; Africa, etc.

Pagyda quadrilineata.

Pagyda quadrilineata Butl. Trans. Ent. Soc. 1881, p. 586; Leech, Trans. Ent. Soc. 1901, p. 452.

A female taken by me at Noma, Tanegashima, June 15, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea.

Cnaphalocrocis medinalis.

Salbia medinalis Guen. Delt. et Pyr. p. 201 (1854); Hmpsn. Moths Ind. IV. p. 275; Leech, Trans. Ent. Soc. 1901, p. 452.

Botys rutilalis Wlk. Cat. XVIII. p. 665 (1859).

Botys iolealis Wlk. Cat. XVIII. p. 666 (1859).

Cnaphalocrocis jolinalis Led. Wien. Ent. Mon. VII. p. 385, pl. 12. f. 7 (1863).

Botys fasciculatalis Wlk. Cat. XXXIV. p. 1431.

Botys acerrimalis Wlk. Cat. XXXIV. p. 1449.

A female taken by me at Kumano, Tanegashima, July 14, 1919.

Local distribut'on, Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Throughout Oriental and Australian regions.

Syngamia floridalis.

Syngamia floridalis Zell. K. Vet.-Ak. Handl. 1852, p. 60; Hmpsn. Moths Ind. IV. p. 280.

Glyphodes calidalis Guen. Delt. et Pyr. p. 294.

Syngamia octarialis Wlk. Cat. XVII. p. 334.

Syngamia merionealis Wlk. Cat. XVII. p. 334.

Syngamia tiphalis Wlk. Cat. XVII. p. 335.

Hyalea fulvidalis Wallengr. Wien. Ent. Mon. 1860, p. 174.

Botys witialis Feld. Reise Nov. pl. 135. f. 8.

A male taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Kiushiu.

General distribution. Japan; Malay; India; Africa.

Bocc oris inspersalis.

Botys inspersalis Zell. Lep. Caffr. p. 33 (1852): Led. Wien. Ent. Mon. VII. p. 434; Hmpsn. Moths Ind. IV. p. 284 (1896); Leech, Trans. Ent. Soc. 1901, p. 454.

Desmia afflictalis Guen. Delt. et Pyr. p. 190, pl. 5. f. 4 (1854).

Aediodes bootanalis Wlk. Cat. XXXIV. p. 1298 (1865).

Desmia stellaris Butl. Ill. Het. B. M. III. p. 73, pl. 58. f. 15 (1879).

A female taken by me at Kitatane, Tanegashima, June 10, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China; India; Africa.

Tyspanodes (?) *striata.*

Astura striata Butl. Ill. Het. B. M. III. p. 76, pl. 59. f. 10 (1879); Leech, Trans. Ent. Soc. 1901, p. 456.

Common in Yakushima and Tanegashima.

Local distribution. Hokkaido; Honshiu; Kiushiu; Shikoku.

General distribution. Japan; Corea; China.

In the hindwings the veins 4 and 5 are not closely approximated, but well separated or slightly approximated, and the veins 6 and 7 shortly stalked. The frons is rounded instead of being flat and oblique.

Dichocrocis punctiferalis.

Astura punctiferalis Guen. Delt. et Pyr. p. 320 (1854); Hmpsn. Moths Ind. IV. p. 307; Leech, Trans. Ent. Soc. 1901, p. 456.

A male taken at Nishinoomote, Tanegashima, July 26, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Malay; India; Australia.

Phryganodes noctescens.

Charema noctescens Moore, Lep. Atk. p. 218 (1888); Hmpsn. Moths. Ind. IV. p. 303; Leech, Trans. Ent. Soc. 1901, p. 457.

A female taken by me at Nishinoomote, Tanegashima, July 27, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Java; Borneo; India.

Nocoleia poeonalis.

Botys poeonalis Wlk. Cat. XVIII. p. 639 (1859); Hmpsn. Moths Ind. IV. p. 313; Leech (part), Trans. Ent. Soc. 1901, p. 458.

Two females taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; India; Borneo; Java; Flores.

Nacoleia misera.

Asopia misera Butl. Ill. Het. B. M. III. p. 74, pl. 59. f. 5 (1879).

Nacoleia poeonalis Leech (part), Trans. Ent. Soc. 1901, p. 458.

A female taken by me at Nishinoomote, Tanegashima, July 26, 1918.

Local distribution. Honshiu ; Kiushiu.

Habitat. Japan.

Nacoleia tristrialis.

Botys tristrialis Brem. Lep. Ost-Sib. p. 68, pl. 4. f. 7 (1864) ; Hmpsn. Moths. Ind. IV. p. 313 ; Leech, Trans. Ent. Soc. 1901, p. 458.

A male taken by me at Kosugitani, Yakushima, July 14, 1918.

Local distribution. Hokkaido ; Honshiu ; Kiushiu.

General distribution. Japan ; China ; Siberia ; India.

Nacoleia tampiusalis.

Botys tampiusalis Wlk. Cat. XVIII. p. 704 (1859) ; Hmpsn. Moths. Ind. IV. p. 318 ; Leech, Trans. Ent. Soc. 1901, p. 460.

Botys ilusalis Wlk. Cat. XVIII. p. 705 (1859).

Aplomastyx minuta Hmpsn. Ill. Het. B. M. VIII. p. 138, pl. 155. f. 23 (1891).

Very common in Yakushima and Tanegashima.

Local distribution. Honshiu ; Kiushiu.

General distribution. Japan ; India ; Borneo.

SWINHOE states that *ilusalis* is quite distinct from *tampiusalis*, and less than half its size.

Goniorhynchus exemplaris.

Goniorhynchus exemplaris Hmpsn. P. Z. S. 1898, p. 705 ; Leech ; Trans. Ent. Soc. 1901, p. 403.

Two males and females taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Honshiu, Kiushiu.

Habitat. Japan.

Sylepta luctuosalis.

Hyalitis luctuosalis Guen. Delt. et Pyr. p. 290 (1854); Hmpsn. Moths Ind. IV. p. 340; Leech, Trans. Ent. Soc. 1201, p. 464.

Botys aemealis Wlk. Cat. XVIII. p. 671 (1859).

Botys cosisalis Wlk. Cat. XVIII. p. 685 (1859).

Ebulea zelleri Brem. Lep. Ost.-Sib. p. 70, pl. 6. f. 12 (1864).

Coptobasis andamanalis Moore, P. Z. S. 1877, p. 615, pl. 60. f. 14.

Hymenia erebina Butl. Ill. Het B. M. II. p. 57, pl. 39. f. 1 (1878).

Very common in Yakushima.

Local distribution. Hokkaido; Honshiu; Kiushiu; Shikoku.

General distribution. Japan; Corea; China; Siberia; Borneo; India.

Sylepta aurantiacalis.

Pyralis aurantiacalis Fisch. V. Röstl. Schmett. p. 213, pl. 75. f. 3 (1843); Hmpsn. Moths. Ind. IV. p. 337; Leech, Trans. Ent. Soc. 1901, p. 465; Rebel, Cat. Lep. pal. p. 54.

Botys aurea Butl. Ill. Het. B. M. III. p. 76, pl. 59. f. 12.

Sylepta balteata Hmpsn. P. Z. S. 1898, p. 718.

A male and a female taken by me at Miyanoura, Yakushima, and at Nishinoomote, Tanegashima, July 11, 28, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; India; Europe.

Sylepta andrewsalis.

Pyrausta andrewsalis Wileman, Trans. Ent. Soc. 1911, p. 389, pl. 30. f. 7.

Several males and females taken by me at Kosugitani, Yakushima. In some females the inner margin of the forewings is not yellow towards base as stated in the original description, the yellow-edged antemedial line is visible only below the cell, and the double yellow spot beyond the cell is present or absent.

Local distribution. Hokkaido; Kiushiu (Yakushima).

Habitat. Japan.

Sylepta sabinusalis.

Botys sabinusalis Wlk. Cat. XVIII. p. 708 (1859); Hmpsn. Moths Ind. IV. p. 333; Leech, Trans. Ent. Soc. 1901, p. 466.

Notareha butyrina Meyr. Trans. Ent. Soc. 1886, p. 260.

Notareha dubia Hmpsn. Ill. Het. B. M. VIII. p. 136, pl. 155. f. 16.

A male taken by me at Nishinoomote, Tanegashima, July 26, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Corea; China; Borneo; India.

Sylepta quadrimaculalis.

Scopula quadrimaculalis Koll. Hüg. Kasch. IV. p. 492; Led. Wien. Ent. Mon. VII. p. 430, pl. 16. f. 12; Hmpsn. Moths Ind. IV. p. 336; Leech, Trans. Ent. Soc. 1901, p. 470.

Three females taken by me at Kosugitani, Yakushima, and at Noma, Tanegashima, July 14, 1918, June 11, 1919.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; China; Borneo; India.

Margaronia telphusalis.

Glyphodes (?) *telphusalis* Wlk. Cat. XIX. p. 974 (1859); Hmpsn. Moths Ind. IV. p. 284.

Heterocnephes reniperalis Snell. Trans. Ent. Soc. 1890, p. 616.

Glyphodes uncinalis Pag. J. B. Nass. Ver. XXXVII. p. 273, pl. 7. f. 6 (1884).

Glypodes albilunalis Wileman, Trans. Ent. Soc. 1911, p. 381, pl. 31. f. 12.

A female taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; Borneo; India.

Margaronia actorionalis.

Glyphodes actorionalis Wlk. Cat. XVII. p. 498 (1859); Hmpsn. Moths. Ind. IV. p. 359.

Glyphodes zelleri Led. Wien. Ent. Mon. 1863, p. 478, pl. 14. f. 3.

Glyphodes conclusalis Wlk. Cat. XXXIV. p. 1354; Hmpsn. Ill. Het. B. M. VIII. pl. 156. f. 12.

A female taken by me at Kumano, Tanegashima, June 14, 1919.

Local distribution. Honshiu (Kii); Kiushiu (Tanegashima).

General distribution. Japan; Malay; India.

Margaronia perspectalis.

Phakellura perspectalis Wlk. Cat. XVIII. p. 515 (1859); Hmpsn. Moths Ind. IV. p. 353; Leech, Trans. Ent. Soc. 1901, p. 472.

Phacellura advenalis Led. Wien. Ent. Mon. VII. p. 401, pl. 13. f, 17.

A male taken by me in Yakushima, July 12, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Corea; China; India.

Margaronia bipunctalis.

Glyphodes bipunctalis Leech, Entom. XXII. p. 70, pl. 3, f. 2 (1889); Trans. Ent. Soc. 1901, p. 475.

A female taken by me in Yakushima, July 1918.

Local distribution. Honshiu; Kiushiu.

Habitat. Japan.

Thliptoceras cascale.

Hapalia cascalis Swinhœ, Trans. Ent. Soc. 1890, p. 271, pl. 8. f. 18; Hmpsn. Moths Ind. IV. p. 377; Leech, Trans. Ent. Soc. 1901, p. 477.

Thliptoceras variabils Swinhœ, Trans. Ent. Soc. 1890, p. 274.

A female taken by HABUTSU in Tanegashima, September 1910.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; India.

Diasemia accalis.

Scopula (?) *accalis* Wlk. Cat. XIX. p. 1015 (1859); Hmpsn. Moths Ind. p. 411; Leech, Trans. Ent. Soc. 1901, p. 487.

A male taken by me at Nishinoomote, Tanegashima, June 9, 1919.

Local distribution. Honshiu; Kiushiu.

General distribution. Japan; China; India.

Pionea genialis.

Botys genialis Leech, Entom. XXII. p. 69, pl. 3, f. 10 (1889); Trans. Ent. Soc. 1901, p. 493.

A female (exp. 18 mm.) taken by me at Nishinoomote, Tanegashima, July 28, 1918.

Local distribution. Kiushiu.

General distribution. Japan; China.

Pyrausta nubilalis.

Pyralis nubilalis Hübn. Samml. eur. Schmett. Pyr. f. 94; Hmpsn. Moths Ind. IV. p. 435; Leech, Trans. Ent. Soc. 1901, p. 503; Rebel, Cat. Lep. pal. p. 65.

Pyralis silacealis Hübn. Samml. eur. Schmett. Pyr. f. 116.

Botys luplinalis Guen. Delt. et Pyr. p. 331 (1854).

Botys zealis Guen. Delt. et Pyr. p. 332 (1854).

Two males and a female taken by me at Miyanoura, Yakushima, July 12, 1918.

Local distribution. Hokkaido; Honshiu; Kiushiu; Shikoku.

General distribution. Japan; Corea; China; Siberia; India; Asia Minor; Europe.

Pyrausta fimbriata.

(Pl. III. fig. 7.)

Parudea fimbriata Swinhoe, Cat. Lep. Oxf. Univ. Mus. II. p. 523, pl. 8. f. 34 (1900).

Two males and a female taken by me at Miyanoura, Yakushima, July 12, 1918.

Hitherto unrecorded from Japan.

Local distribution. Kiushiu (Yakushima).

General distribution. Japan; China.

Fam. **Orneodidæ.**

Orneodes ochracea. n. sp.

Palpi ochraceous whitish, second joint rough scaled towards extremity, thickly irrorated with fuscous, third banded with fuscous at middle. Antennae ochraceous whitish, sparsely irrorated with fuscous towards base. Head whitish ochreous, tinged with fuscous on frons and on vertex. Thorax whitish ochreous with two fuscous transverse bands. Legs white, fore tibiæ fuscous, mid tibiæ with the basal half suffused with dark grey. Abdomen, ochreous thickly irrorated with fuscous, a dorsal white spot at the hind margin of each segment. Forewings ochreous; first segment tinged with fuscous towards base, with 4 fuscous rather large spot edged with oblique white marks, a fifth at apex; segments 2–6 crossed by two fuscous bands edged with white lines, first median, excurved and broadest on fifth segment, second subterminal, incurved at middle and on inner margin, broadest on third segment, narrowest on fifth segment; each segment with a black apical dot; cilia dark grey. Hindwings ochreous, basal area irrorated with dark fuscous; segments crossed by two more or less irregular fuscous bands as on forewings but less distinct and darker towards inner margin, each segment with two blackish spots between the bands, a black spot at end of each segment; cilia as on forewings.

Expanse, ♂ 11 mm.

A male taken by me in Tanegashima, June 10, 1919.

Fam. **Alucitidæ.**

Pselnophorus japonicus. n. sp.

(Pl. III. fig. 10.)

Head and thorax dark fuscous; palpi whitish; pectus whitish, tinged with fuscous. Abdomen above dark fuscous more or less irrorated with white, beneath white banded with fuscous. Hind tibiæ with a basal, medial, and apical dark fuscous band, tarsi white with the basal joint slightly tinged with fuscous. Wings dark fuscous. Forewings with a discoidal white lunule, an antemedial small white spot in cell, sometimes obsolete, first cleft with two

white small streaks near extremity, one at apex and another before apex on lower margin; second cleft with a white streak at apex; cilia blackish with a white spot at apex and on lower margin of first cleft, two white spots on costa before apex, and on lower margin of second cleft. Hindwings sometimes with a white spot in cell; cilia of lower margin of second cleft spotted with white near apex.

Expanse, 14–16 mm.

Three males taken by me at Noma, Tanegashima, June 11, 14, 1919.

Fam. **Simæthidæ.**

Simaethis yakushimensis. n. sp.

(Pl. III. fig. 8.)

♀. Head orange fulvous sprinkled with whitish. Palpi white, second and terminal joints with basal and subapical fulvous bands. Antennæ white ringed with black. Thorax orange fulvous, posteriorly mixed with dark fuscous and slightly whitish sprinkled. Abdomen dark fuscous irrorated with orange ochreous. Posterior tibiæ whitish ochreous banded with dark fuscous, tarsi whitish, first and second joints with subapical fulvous rings, two apical joints dark fuscous. Forewings triangular, costa moderately arched, apex obtuse, termen almost straight, somewhat oblique; orange ochreous irrorated with whitish; antemedial band slightly sinuous, ferruginous brown mixed with black, followed by a posteriorly undefined shade of whitish irroration; postmedial anteriorly somewhat ill-defined band strongly bent outwards below costa, bidentate at middle, broken inwards below it and minutely bidentate; defined by whitish on its outer side; subterminal band black, interrupted at middle; terminal line black; cilia red-brown mixed with dark fuscous at apex, at middle and at tornus. Hindwings dark fuscous; subterminal line red-brown, only distinct towards tornus; terminal line black; cilia red-brown with the tips whitish.

Expanse 12 mm.

A female taken by me at Miyanoura, Yakushima, July 12, 1918.

Simaethis(?) *albifascialis.* n. sp.

(Pl. III. fig. 9.)

♂. Head and thorax fulvous sprinkled with whitish. Palpi white, second joint with basal and subapical fulvous brown bands, terminal joint mixed with fulvous brown. Antennæ white ringed with black. Abdomen dark fuscous tinged with fulvous. Posterior tibiæ fulvous brown irrorated with white, tarsi white, first and second joints with subapical fulvous brown rings, two apical joints fulvous brown. Forewings triangular, costa moderately arched, apex rather obtuse, termen slightly sinuous; fuscous brown tinged with ferruginous especially on terminal area; basal area orange ochreous, defined on each side by a shade of white irroration; a white streak on discocellulars; postmedial line white defined by dark fuscous on inner side below middle, double towards costa, excurved at middle, then incurved and slightly waved; cilia red-brown, tips whitish, with a blackish line at base, tinged with blackish at apex, at middle and at tornus. Hindwings dark fuscous, traces of subterminal line near tornus; cilia red-brown, tips whitish, blackish line at base.

Expanse 13 mm.

A male taken by me at Nishinoomote, Tanegashima, June 10, 1919.

Another male taken at Miyanoura, Yakushima, July 12, 1918.

Fam. **Plutellidæ**.

Plutella maculipennis.

N. g. *maculipennis* Curtis, Guide, p. 186 (1831).

Cerostoma maculipennis Curtis, Brit. Ent. pl. 420 (explanation p. 2) (1832); Steph. Ill. Brit. Ent. Haust. IV. p. 342; Wals. and Durr. Ent. Mon. Mag. 1897, p. 173; Rebel, Cat. Lep. pal. p. 137.

Cerostoma annulatellus Wood, Ind. Ent. pl. 49, 1547 (1839).

Plutella cruciferarum Zell. Stett. Ent. Zeit. 1843, p. 281.

Plutella xylostella Staud. et Wocke, Cat. p. 281 (1871).

A male taken by me at Noma, Tanegashima, June 14, 1914.

Local distribution. Hokkaido; Honshiu; Kiushiu.

General distribution. Japan; Siberia; Europe.

In order to facilitate the general consideration of the faunal feature of the two islands I append here the following table illustrating the geographical distribution of respective species.

Localities. / Species.	Formosa.	Loochoo.	Yakushima.	Tanegashima.	Kiushiu.	Shikoku.	Honshiu.	Hokkaido.	Other localities.	
									Palæarctic.	Oriental.
Nola trilinea n. sp.				×						
Lexis immaculata Butl.	×		×				×?		×	×
Ilema affineola Brem.										
Asura intermedia n. sp.			×							
Diacrisia subcarnea Wlk.	×	×	×		×		×		×	
Utetheisa pulchella Linn.	×	×		×	×		×		×	×
Cirphis flavostigma Brem.	×		×		×		×	×	×	×
Delta intermedia Brem.				×	×		×		×	×
Phyllophila obliterata Rmbr			×		×		×		×	
Lithacodia signifera Wlk.			×		×		×		×	×
Naranga ænescens Moore.	×			×	×		×		×	
Phlogophona sinuosa Moore			×				×			×
Cotocala prægnax Wlk.				×	×		×	×	×	
Erebus crepuscularis Linn.		×	×		×	×	×	×	×	×
Metopta rectifasciata Mén.	×		×	×	×	×	×	×	×	
Ophisma gravata Guen.		×		×					×	×
Parallelia curvata Leech.		×		×			×		×	
Chalciope hyppasia Cram.	×	×	×						×	×
Mocis undata Fabr.	×		×		×		×		×	×
Mocis anneta Butl.			×		×	×	×	×	×	
Phytometra daubei Boisd.			×	×					×	×
Thermesia ussuriensis Brem.			×		×	×	×	×	×	
Hypocala subsatura Guen.			×				×		×	×
Oraesia emarginata Fabr,			×		×		×		×	×
Oræsia excavata Butl.				×	×		×		×	
Plusiodonta cœlonota Koll.		×		×	×		×		×	×
Pseudaglossa pryeri Butl.			×		×		×			
Edessena hamada Feld.				×	×		×		×	
Dichromia trigonalis Guen,	×		×	×	×		×		×	×
Porthesia pulverea Leech.		×	×	×	×		×		×	
Porthetria dispar Linn.			×						×	
Porthetria nobunage Nagano.			×				×			

Species. / Localities.	Formosa.	Looehoo.	Yakushima.	Tanegashima.	Kiushiu.	Shikoku.	Honshiu.	okkaido.	Other localities.	
									Palæ-arctic.	Orien-tal.
Nyctemera mundipicta Wlk.			×							×
Nyctemera plagifera Wlk.	×	×	×						×	×
Nyctemera cenis Cram.	×	×	×	×						×
Herse convolvuli Linn.	× ?	×	×		×	×	×	×	×	×
Cephonodes xanthus Roths et Jord.		×		×						
Gurelca masuriensis Butl.	×			×					×	×
Gurelca hyas Wlk.	×		×	×	×		×		×	×
Macroglossum pyrrhosticta Butl.		×	×	×	×					×
Theretra oldenlandiæ Fabr.			×	×	×	×	×	×	×	×
Theretra silhetensis Wlk.	×	×	×	×	×				×	×
Ramesa straminea Moore.				×	×		×		×	
Urapteryx subpunctaria Leech.			×	×	×		×			
Thinopteryx crocoptera Koll.			×		×		×		×	×
Synegia esther Butl.			×		×		×		×	
Synegia hadassa Butl.			×		×		×		×	
Scionomia mendica Butl.			×				×	×	×	
Zethenia rufescentaria Motsch.			×		×		×	×	×	
Heterolocha laminaria H.-Sch.				×			×	×	×	
Corymica specularia Moore.			×				×		×	×
Spilopera gracilis Butl.			×				×		×	×
Rhynchobapta flaviceps Butl.				×	×		×		×	×
Macaria pluviata F.				×	×					
Tephrina semilutata Led.			×		×		×	×	×	
Arichanna jaguararia Guen.			×						×	
Abraxas miranda Bult.			×						×	
Asthena erectaria Leech.			×				×	×		
Cidaria saturata Guen.			×						×	×
Photoscotosia atrostrigata Brem.			×						×	
Scopula steganioides Butl.			×		×		×		×	

Species. \ Localities.	Formosa.	Loochoo.	Yakushima.	Tanegashima.	Kiushiu.	Shikoku.	Honshiu.	Hokkaido.	Other localities. Palæarctic.	Other localities. Oriental.
Scopula lactea Butl.				×	×		×		×	
Scopula ignobilis Warr.			×		×		×		×	
Scopula satsumaria Leech.			×		×					
Scopula hanna Butl.			×	×			×		×	
Scopula apicipunctata Christ.			×		×				×	
Scopula coniaria Prout;			×		×		×			
Scopula plumbearia Leech				×	×					
Timandra amata Linn.			×		×	×	×	×	×	×
Chloromachia infracta Wileman.			×				×			
Gelasma albistrigata Warr.			×		×		×			
Doratoptera virescens n. sp.			×	×						
Epiplema moza Butl.				×	×		×			×
Epiplema cretacea Butl.				×	×		×			
Miresa inornata Wlk.			×		×		×	×	×	×
Microleon longipalpis Butl.			×		×		×		×	
Euploea tytia Gray.	×	×	×		×	×	×	×	×	×
Ypthima argus Butl.			×	×	×	×	×	×	×	
Neope goschkewitschii Mén.			×	×	×	×	×	×		
Melanitis phedisma Cram.	×	×		×	×	×	×		×	×
Melanitis leda Linn.	×			×	×	×	×		×	×
Mycalesis gotama Moore.		×	×	×	×	×	×		×	
Dichorragia nesimachus Boisd.	×	×	×	×	×	×	×		×	×
Cyrestis thyodamas Boisd.	×	×	×	×	×	×	×		×	×
Neptis hylas Linn.	×	×		×	×	×	×	×	×	×
Junonia orithya Linn.	×	×	×	×	×				×	×
Junonia almana Linn.	×	×	×	×					×	×
Pyrameis cardui Linn.	×	×	×	×	×	×	×	×	×	×
Vanessa canace Johans.	×	×	×	×	×	×	×	×	×	×
Argynnis nerippe Feld.			×	×	×	×	×	×	×	
Argynnis sagana Doubl.			×	×	×	×	×	×	×	
Argynnis hyperbius Johans.	×	×	×	×	×	×	×		×	×
Hebomoia glaucippe Linn.	×	×	×	×					×	×
Pieris rapae Linn.			×	×	×	×	×	×	×	

Species. \ Localities.	Formosa.	Loochoo.	Yakushima.	Tanegashima	Kiushiu.	Shikoku.	Honshiu.	Hokkaido.	Other localities.	
									Palæarctic.	Oriental.
Pieris melete Mén.			×	×	×	×	×	×	×	×
Anthocharis scolymus Butl.			×	×	×	×	×	×	×	
Eurema læta Boisd.	×	×	×	×	×	×	×		×	×
Eurema hecabe Linn.	×	×	×	×	×	×	×			×
Colias hyale Linn.	×	×	×	×	×	×	×	×	×	
Arhopala japonica Murray.	×	×	×	×	×	×	×		×	
Arhopala bazalus Hew.			×	×	×	×	×		×	×
Curetis acuta Moore.			×	×	×	×	×		×	×
Polyommatus boeticus Linn.	×	×	×	×	×	×	×		×	×
Nacaduva atrata Horsfield.	×	×	×	×						×
Zizera maha Koll.	×	×	×	×	×	×	×		×	×
Everes argiades Pallas.	×	×	×	×	×	×	×	×	×	×
Cyaniris argiolus Linn.	×	×	×	×	×	×	×	×	×	×
Taraka hamada Druce.				×	×	×	×		×	×
Libythea celtis Fuessly.			×	×	×	×	×	×	×	×
Eques alcinous Klug,	×	×	×	×	×	×	×		×	
Eques protenor Cram.	×	×	×	×	×	×	×			×
Eques memnon Linn.	×	×	×	×	×	×			×	×
Eques bianor Cram.	×	×	×	×	×	×	×	×	×	×
Eques helenus Linn.	×	×	×	×	×	×	×		×	×
Eques xuthus Linn.	×	×	×	×	×	×	×	×	×	×
Eques machaon Linn.			×	×	×	×	×	×	×	×
Eques sarpedon Linn.	×	×	×	×	×	×	×	×	×	×
Rhopalocampta benjamini Guér.	×	×	×	×	×	×	×	×	×	×
Parnara mathias Fabr.	×	×	×	×	×	×	×			×
Padraona flava Murray.			×	×	×	×	×			
Notocrypta curvifascia Feld.	×	×	×	×	×				×	
Procris tristis Brem.				×			×		×	
Heterusia ædea Linn.		×		×	×		×		×	×
Erasmia pulchella Hope.		×	×		×				×	×
Callidula formosana Wileman.	×		×	×						
Deroca phasma Butl.			×		×		×			
Lamoria inostentalis Wlk.	×		×		×		×	×	×	×
Crambus diplogrammus Zell.			×		×		×		×	

Species. \ localities.	Formosa.	Loochoo.	Yakushima.	Tanegashima.	Kiushiu.	Shikoku.	Honshiu.	Hokkaido.	Other localities. Palæarctic.	Other localities. Oriental.
Crambus argyrophorus Butl.			×		×		×		×	×
Ancylolomia chrysographella Koll.	×		×		×	×	×	×	×	×
Leechia sinnosalis South.			×				×		×	
Patissa fulvosparsa Butl.				×	×		×		×	×
Sciryophaga auriflua Zell.			×		×		×		×	×
Nephopteryx semirubella Scop.			×	×	×	×	×	×	×	×
Etiella zinckenella Treit.				×	×		×		×	×
Endotricha consocia Butl.			×		×		×	×	×	
Endotricha theonalis Wlk.	×			×	×		×	×	×	
Stemmatophora bicoloralis Leech.			×				×		×	×
Herculia pelasgalis Wlk.			×	×	×		×		×	
Bostra marginata Wlk.				×	×		×		×	×
Cataclysta junctalis Hmpsn.				×						×
Musotima acclaralis Wlk.			×	×						×
Bradina admixtalis Wlk.			×	×	×		×			×
Diathrausta picata Butl.				×	×		×		×	×
Piletocera sodalis Leech.			×	×	×		×		×	
Piletocera ægimiusalis Wlk			×		×					×
Camptomastyx hisbonalis Wlk.			×	×	×				×	×
Zinckenia recurvalis Fabr.	×		×	×	×		×	×	×	×
Pagyda quadrilineata Butl.				×	×		×		×	
Cnaphalocrocis medinalis Guen.				×	×		×		×	×
Syngamia floridalis Zell.			×							×
Bocchoris inspersalis Zell.				×	×		×		×	×
Tyspanodes(?) striata Butl.			×	×	×	×	×	×	×	
Dichocrocis punctiferalis Guen.				×	×		×		×	×
Phryganodes noctescens Moore.				×	×		×		×	×
Nacoleia præonalis Wlk.			×		×		×		×	×
Nacoleia misera Butl.				×	×		×			

Localities. / Species.	Formosa.	Loochoo.	Yakushima.	Tanegashima.	Kiushiu.	Shikoku.	Honshiu.	Hokkaido.	Other localities. Palæarctic.	Other localities. Oriental.
Nacoleia tristrialis Brem.			×		×		×	×	×	×
Nacoleia tampiusalis Wlk.			×	×			×			×
Goniorhynchus exemplaris Hmpsn.			×				×			
Sylepta luctuosalis Guen.			×		×	×	×	×	×	×
Sylepta aurantiacalis Fisch.			×	×	×		×		×	×
Sylepta andrewsalis Wileman.			×					×		
Sylepta sabinusalis Wlk.				×	×		×		×	×
Sylepta quadrimaculalis Koll.			×		×		×	×	×	×
Margaronia telphusalis Wlk.			×		×		×			×
Margaronia actorionalis Wlk.				×			×			×
Margaronia perspectalis Wlk.			×		×		×	×	×	×
Margaronia bipunctalis Leech.			×		×		×			
Thliptoceras cascale Swinhoe.				×			×?			×
Diasemia accalis Wlk.				×	×		×		×	×
Pionea genialis Leech.				×	×				×	
Pyrausta nubilalis Hübn.			×		×	×	×	×	×	×
Pyrausta fimbriata Swinhœ.			×						×	
Orneodes ochracea n. sp.			×	×						
Pselnophorus japonicus n sp.				×						
Simaethis yakusimensis n. sp.			×							
Simaethis (?) albifascialis n. sp.			×							
Plutella maculipennis Curtis.				×	×	×	×	×	×	

EXPLANATION OF PLATE III.

Fig. 1. *Nola trilinea* n. sp. ♂. ×2.

Fig 2. *Asura intermedia* n. sp. ♂. ×2.

Fig. 3. *Porthetria dispar* Linn. ♂. ×1.

Fig. 4. *Doratoptera* (?) *virescens* n. sp. ♀. ×1.

Fig. 5. *Neope goschkewitschii* Mén. ♂. Underside of hindwing. ×1.

Fig. 6. *Callidula formosana* Wileman. ♀. ×1.

Fig. 7. *Pyrausta fimbriata* Swinhœ. ♂. ×1·5.

Fig. 8. *Simæthis yakushimensis* n. sp. ♂. ×2.

Fig. 9. *Simæthis* (?) *albifuscialis* n. sp. ♂. ×2.

Fig. 10. *Pselnophorus japonicus* n. sp. ♂. ×3.

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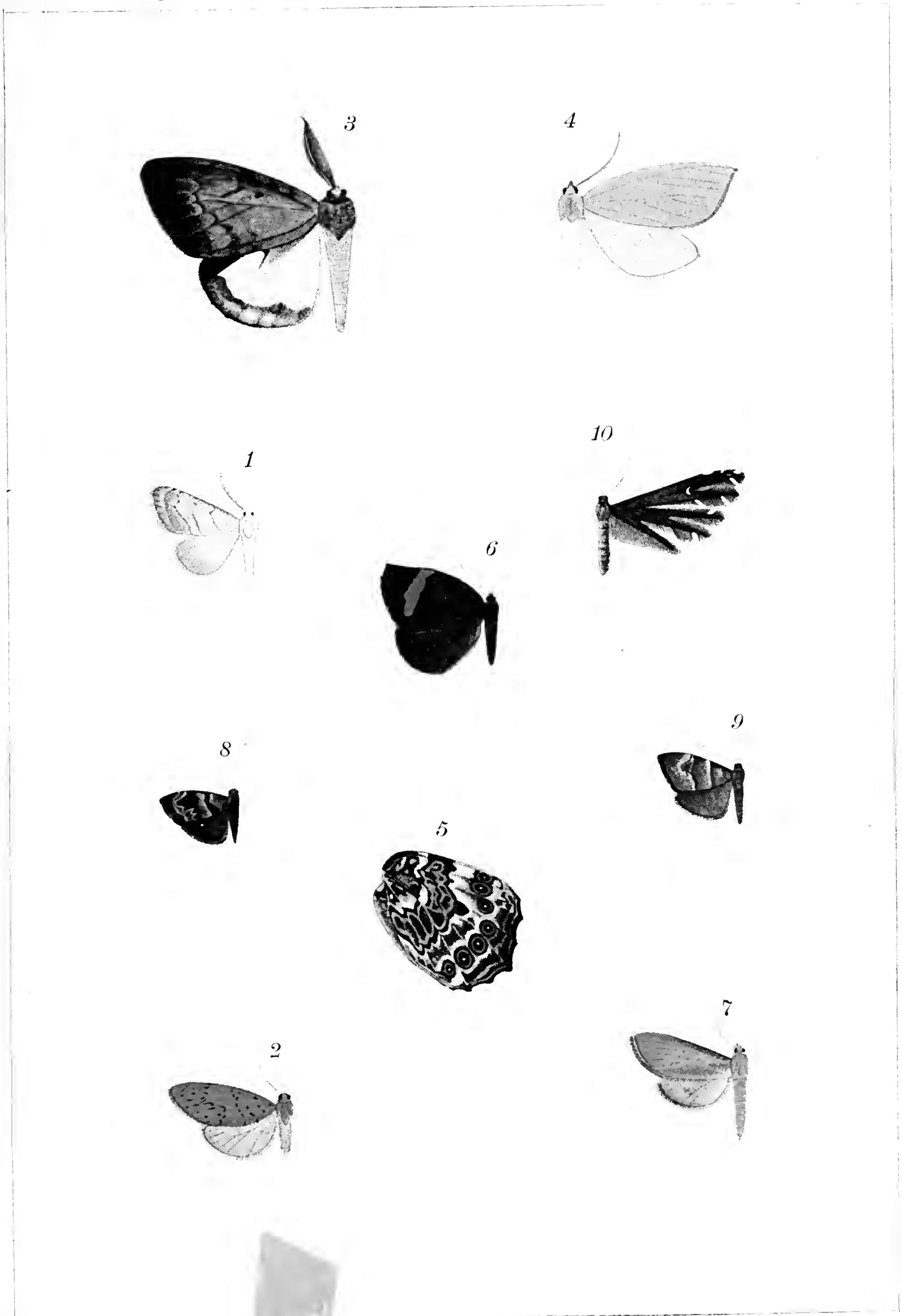


The Spermatogenesis of Domestic Mammals.

III. The Spermatogenesis of the Mouse and of the Rabbit.

By

Kiyoshi Masui.

(From the Laboratory for Agricultural Zoology, Director: Professor C. Ishikawa.)

With Plates IV-X and one Text-Figure.

The chromosomes are now generally proved to occur in pairs both in germ cells as well as in somatic cells. In mammals, however, owing to their great number, it is very difficult to determine their relation accurately, and the results of the investigations obtained by various workers, differ so greatly, that renewed studies are always to be welcomed, even in one and the same animals.

It is for this reason, that the present investigation was undertaken, the original object of which was chiefly the study of the chromosomes, but in the course of the investigation it was found necessary to extend the researches to the cytoplasmic structures as well. The result was the present paper which deals with the entire spermatogenesis of the mouse and of the rabbit.

The author has prepared the present paper under the direction of Professor Chiyomatsu Ishikawa to whom he wishes to express his hearty thanks for the painstaking care and sympathy given him throughout the course of this study.

Materials and Methods.

The materials on which this study is based, consist of the testes of piebald mice at different ages and those of young rabbits.

As is already known, it is difficult to obtain good results in the fixation of chromosomes in mammals. In materials which have been insufficiently prepared, the chromosomes are usually so closely massed, that it is impossible to obtain any results which can be used for cytological study. Consequently, as HANCE ('17 b) stated, it is quite true that most of the published cytological works on mammals are not reliable and should be carefully repeated.

For the fixation, therefore, several fixatives were used, namely, a modification of HANCE's method, FLEMMING's mixture, BOUIN's fluid, sublimate acetic and CHAMPY's fluid, but the first method gave the most satisfactory results.

The method of fixation used chiefly in this study is as follows:—1. The material used must be absolutely fresh and cut into very small pieces. 2. These are put immediately into FLEMMING's solution (weak) to which a little urea is added; in this the tissues remain from twenty to twenty four hours. 3. The temperature of the fixatives is about 15 degrees Centigrade. 4. Sections are bleached for from five to twenty hours in hydrogen peroxide.

For the fixation of the mammalian chromosomes HANCE ('17a, b)[1] obtained some excellent results with FLEMMING'S cold strong solution which is cooled to about four degrees Centigrade; but my experience has shown that FLEMMING's fluid, either strong or week, kept at about fifteen degrees Centigrade is more preferable than the cold solution.

For the study of the chromosomes the sections were stained with HEIDENHAIN's iron-hæmatoxylin, and for the mitochondria also the same stain was used, though the preparations were fixed in this case with CHAMPY's fluid. The mitochondria can, however, be also differentiated in the preparation fixed with FLEMMING'S strong solution to which a few drops of acetic acid are added. As control AUERBACH's method (methyl-green and acid-fuchsin) was frequently used. This method has been found most useful as a differential stain for chromatin and nucleoli.

1. His explanation on the action of the cold FLEMMING's solution is as follows:—"It seems more probable that the explanation for the success of the cold fixation may lie in the suppression of metabolic activities when the preservation of the living structures until the fluid is able to penetrate and fix them permanently."

Observations.

I. The Spermatogonia.

A. The spermatogonia in the mouse.

As I have already described in cattle, in the testes of mature animals several sizes of spermatogonial cells can be distinguished (Figs. 4, 14). This difference in size seems to indicate the generations of the spermatogonia, the larger cells being earlier in generation than the smaller ones. It is, however, a difficult matter to determine accurately the number of generations of the spermatogonia.

The resting nucleus of every spermatogonial cell usually contains one nucleolus and several chromatin masses which usually lie on the nuclear membrane and on the linin threads (Figs. 126, 127). The nucleolus gives an appearance of granular construction, since a small amount of chromatin granules are gathered on the surface of it (Figs. 126, 127). Thus it is difficult to distinguish the nucleolus in the preparations stained with iron-hæmatoxylin (Figs. 1, 2), while this can clearly be seen in those stained with Auerbach's method (Fig. 127).

The nucleolus gradually disappears in the prophase, leaving a plastin remnant behind; thus it is clear that there is no connection between this body and the sex-chromosomes which are found in the prophase of the first reduction division. The chromatin granules later begin to arrange themselves along short threads which correspond to the chromatin spiremes in other animals (Fig. 2). The chromatin threads now become gradually denser and thicker until the granular appearance is entirely lost to view (Fig. 3). As stated, above, the nucleolus usually disappears at the late prophase but it remains sometimes among the chromosomes in the early metaphase (Fig. 127). This, however, can not be recognized, when the chromosomes are arranged radially around the central space in the metaphase.

As the mitotic figures are rare in mammalian tissues compared with those of the lower animals, in the determination of the number of chromosomes the method of using thick sections is, in my experience, preferable to the smear method. As Montgomery ('10) stated, it is true that the difficulty in determining the number of chromosomes increases in geometrical ratio with

the increas of theire number. Owing to this fact, for the determination of the number of chromosomes only those cells were selected which were clearly recognized as being uncut, and in which the chromosomes were so distinctly separated from each other that the count could be made easily and accurately (Figs. 4, 5).

Nearly all the cells studied contain forty chromosomes. Details as to the number of chromosomes are given in the following table.

TABLE I. Showing number of chromosomes.

In determining the number, every chromosome was carefully drawn with the aid of a camera-lucida at the magnification 2000 diameters. In order to avoid miscounting the drawing was carefully compared with the chromosomes of the section under the microscope.

Thickness of sections.	10μ		5μ	
Number of chromosomes.	40	39	35	total.
Number of cases.	21	1	2	24

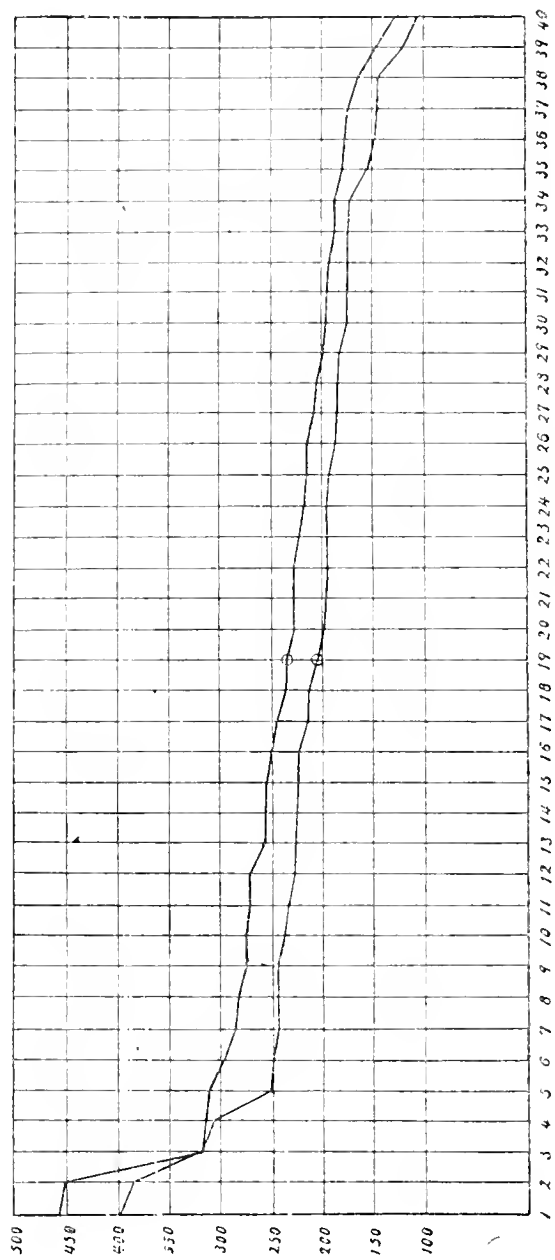
As shown in the above table, among the 22 thick sections only one cell contains thirty nine chromosomes. This difference in number, however, is probably due to miscounting.

From the above, it is evident that the chromosomes of the male germ cell of the mouse are constantly forty in number. The chromosomes in every spermatogonial cell vary considerably in size and form, and usually assume a somewhat curved rod- or straight rod-shape. When the chromosomes are arranged according to size and form, it is found that pairs exist among them, although they form a series which falls gradually from the largest to the smallest (Figs. 9–12). The following table and the text figure show this relation clearly.

TABLE II. Representing area of spermatogonial chromosomes at a magnification of 32000 diameters.

Method of measurement:—A definite number of homogeneous papers (ten pieces of paper to each chromosome) which have the same size and form as each magnified chromosome and a standard area of the same paper were accurately weighed with a balance. From a comparison between the weight of the former and that of the latter, the area of each chromosome was calculated.

Chromosomes.	Area in sq. mm. I	Area in sq. mm. II
1	399,7	460,0
2	388,2	453,0
3	316,3	315,9
4	307,4	313.7
5	253,7	310,2
6	250,0	298,0
7	245,9	285,0
8	245,6	283,8
9	244,8	276,2
10	238,8	275,1
11	234,2	272,6
12	229,0	271,7
13	228,5	259,7
14	225,7	258,5
15	222,9	255,7
16	222,5	247,8
17	213,9	245,9
18	212,6	234,3
19	205,2	233,5
20	199,3	229,8
21	196,0	228,9
22	194,6	228,0
23	193,8	221,7
24	193,3	218,6
25	191,0	214,9
26	187,3	211,1
27	186.0	209,4
28	185,5	201,3
29	181,2	199,9
30	175,8	197,3
31	175,0	194,6
32	173,8	192,5
33	173,7	184,2
34	171,7	183,8
35	155,5	179,2
36	147,4	177,6
37	145,8	171,0
38	144,8	162,3
39	120,0	150,0
40	107,6	129,3



Text-fig. 1. Curves representing size relation of chromosomes.

The figures on the axis of ordinates represent size of chromosomes in sq. mm., while these along the base line are the number of chromosomes arranged according to size. The upper curve represents the size of chromosomes of Fig. 10, and the lower one that of Fig. 9.

Details of the chromosomes will be discussed later on in the considerations, pp. 234.

The chromosomes become arranged in the equatorial plate with their long axes coinciding with the latter (Fig. 7). Every chromosome now simultaneously divides into two portions along the longitudinal split, no special chromosomes with different behavior being seen among them (Figs. 8, 14). At the anaphase U- or V-shaped chromosomes which are usually observed in other animals are not produced, they assume simple rod-shap (Fig. 14).

As the spindles can not clearly be seen, it is difficult to determine directly the point of attachment of the spindle fiber. It is, however, conceivable that, if the spindle fiber attaches to the end of a chromosome, the daughter chromosomes in the anaphase must assume straight rod-shape. For this reason it seems certain that in the mouse the spindle fibers must attach to the ends of the chromosomes. ALLEN ('18) also proposed the same view in the rat, where he says: "It will be of interest to learn if it is characteristic of rodents or peculiar to the rat."

In the preparation stained with AUERBACH's method a cytoplasmic mass can usually be found in close contact to the nuclear wall, while in HEIDENHAIN's method nothing can be seen in the cytoplasm (Fig. 127). Although this mass is not so conspicuous as the idiozome in the spermatocyte, its appearance and its situation correspond almost exactly with those of the latter cells, so that I do not hesitate to identify it with the same. DUESBERG ('08) and ALLEN ('18) have not found the idiozome in the spermatogonia of the rat.

The mitochondrial granules appear in the cytoplasm, being scattered throughout the latter (Fig. 6). The amount seems to be the same as those of the young spermatocyte. In the metaphase they remain undivided and lie outside the spindle (Fig. 6). After the cell is divided into two the mitochondrial granules seem to be equally distributed in the cytoplasm of the daughter cells. The size of the granules appears to be smaller than that in the prophase of the first reduction division.

B. The spermatogonia in the rabbit.

As in the mouse, we can distinguish several kinds of spermatogonial cells which are probably of different generations (Figs. 85–87). The resting nuclei of the spermatogonial cells usually contain many chromatin masses (karyosomes) and several nucleoli which can clearly be seen in the sections stained with AUERBACH's method (Fig. 145).

During the early prophase many chromatin masses appear which gradually elongate and form the fine chromatin spiremes (Figs. 85, 86). Soon after the spiremes become thicker and are convoluted throughout the nucleus (Figs. 85, 86). At this stage nucleoli can not be seen at all (Fig. 86). In

the late prophase many long and variously curved chromosomes appear which are entangled with each other (Fig. 86). In the metaphase it is difficult to make out every chromosome, for the long, curved chromosomes overlap each other, notwithstanding the perfect separation of the individual ones (Fig. 87).

It has been found that the number of chromosomes is not constant but is considerably variable (Figs. 87–91). For counting the chromosomes only those cells were selected which were clearly found to be uncut and in which the chromosomes were well separated (Figs. 87–91). It is therefore clear that the variation of the number of chromosomes is not caused by the use of poorly prepared materials. The seventeen cells studied in this connection fall into the groups:—

TABLE III, Showing variation in the number of chromosomes.

Thickness of sections.	8μ						
Number of chromosomes.	44	47	48	49	51	54	Total
Number of cases.	1	6	2	3	2	3	17

As in the mouse, the chromosomes vary considerably in size and form (Figs. 87, 88). The larger chromosomes are considerably long and variously curved, while the smaller ones appear as round bodies (Figs. 87, 89). Some larger ones are strongly curved and sometimes the transverse constrictions can be seen at their ends (Figs. 87–91). It is remarkable that in those cells which contain a large number of the chromosomes, the smaller ones increase in number, while in those having forty eight chromosomes only four smaller ones can be seen (Figs. 89–91). From the above facts it is conceivable that this difference in the number of chromosomes is probably due to the influence of the fixatives.

The arrangement and the dividing method of the chromosomes are equal to those of the mouse (Figs. 92–95). As all the chromosomes assume simply the straight rod-shape in the anaphase, it seems most probable that the

attachment of the spindle fiber is terminal, although as in the mouse the point of attachment can not be seen (Figs. 92, 94).

In the resting spermatogonia the idiozome can clearly be seen as a long ellipsoid and is situated constantly in close contact to the nuclear wall (Fig. 145).

The mitochondrial granules appear abundantly in the cytoplasm. Their size and their behavior are entirely the same as those of the mouse (Fig. 93).

II. The Growth Period of the Spermatocyte.

A. The growth period of the spermatocyte in the mouse.

In the final telophase of the spermatogonia the chromosomes break up into a confused net-like structure, and for a short time the outline of the individual chromosome can not be distinguished (Fig. 129). Soon after many chromatin masses appear, connected with fine threads (Fig. 15). The number of the chromatin masses is almost equal to that of the spermatogonial chromosomes.

The pre-synaptic stage:—At the beginning of this stage the irregular chromatin masses which appeared in the previous stage begin to elongate and finally become the chromatin threads which are comparable to those of cattle, but they are very short and appear as irregular chromatin rods (Fig. 16). Even though the number of the chromatin threads can not be exactly counted in this stage, it is clearly shown that their number is not far from that of the spermatogonial chromosomes (Fig. 16). In the preparations stained with Auerbach's method, all the chromatin threads are stained intensely with methyl-green, and no nucleolus is found in any part of the nucleus (Figs. 129, 130).

In this stage the mitochondrial granules appear in small number in the cytoplasm (Fig. 16).

The synaptic stage:—After the brief duration of the pre-synaptic stage the chromatin threads soon begin to converge towards one side of the nucleus, leaving a clear space on the other side (Figs. 17, 130). But the tendency of the polarization of the chromatin threads is not so conspicuous as that

of the horse and of cattle. From an accurate observation, it is most probable that this slight polar aggregation of the chromatin threads is to be looked upon as the synizesis which corresponds to that of the other animals.

DUESBERG ('08) denied the occurence of synizesis in the rat. Recently ALLEN ('18) found a slight aggregation of the chromatin threads in this animal, but his view is different from mine. He says: —"A very slight polar aggregation may occur during this period but no synizesis has been observed with any method of fixation." JORDAN ('14) rarely found the synizesis occuring in the mouse, he says: "This is tentatively interpreted as synapsis (polarized amphitène). If the nucleus is normal, as it appears to be, the paired threads unmistakably indicate synapsis."

As is the case in the horse and cattle, in this stage the nuclear wall expands rapidly and soon apparently disintegrates (Fig. 130). During this stage the parallel arrangement of the spiremes can not be seen at all (Figs. 16–18). With AUERBACH's method the spiremes take the same colour as in the previous stage (Fig. 130).

Most of the mitochondrial granules are usually grouped near the pole of nucleus where the chromatin threads converge, but none of them attach to the nuclear wall (Fig. 16).

Neither the nucleolus nor the idiozome can be seen during this stage (Fig. 130).

The post-synaptic stage:—In the stage immediately following the synaptic stage the chromatin threads gradually spread throughout the nucleus, becoming more loosely situated (Figs. 18, 19). At the beginning of this stage some spiremes appear to form an end-to-end arrangement which is regarded as an indication of telosynapsis (Figs. 17, 18). In any case it is quite certain that in this stage the spiremes appear about half the original number, but they do not increase in thickness, retaining their original form (Figs. 17, 18). From this fact it is conceivable that the conjugation of chromosomes must have taken place during the previous stage (synaptic stage). Later on the chromatin threads elongate more and more until they resemble as those of the horse and cattle, while the outline of the nucleus becomes spherical and more clearly defined (Fgs. 18, 19, 131). With AUERBACH's method all the

spiremes of this stage are still stained deeply with methyl-green (Fig. 131).

At the end of this stage a nucleolus appears, usually situated close to the nuclear wall (Figs. 131, 132). It is stained both with fuchsin and methyl-green at the same time with AUERBACH'S method, while with iron-hæmatoxylin it takes the chromatin dye (Figs. 19, 131). As the nucleolus is small in the beginning of this stage, it is difficult to distinguish it in the sections stained with iron-hæmatoxylin (Fig. 18). The nucleolus grows rapidly, increasing the staining capacity for acid-fuchsin, while the bulk of the cell gradually increases and the movement of the chromatin spiremes is carried out further until they fill up the nucleus throughly (Figs. 19, 20). The longitudinal splitting of chromosomes could not be observed in this stage (Figs. 18–20).

The early prophase:—With the growth of the nucleolus the chromatin threads[1] become faintly stained with iron-hæmatoxylin by which they show granular appearance, while with AUERBACH'S method they begin to stain both with methyl-green and acid-fuchsin at the same time (Figs. 21–23, 134). As will be shown in the subsequent chapter, it seems more probable that this change of staining capacity is due to the chemical change connected with the growth of the chromosomes. With the growth of the cell this change of the staining capacity proceeds more and more until it reaches its maximum in the late prophase where the cells attain the greatest zise (Figs. 25, 27, 134).

In this stage, beside the nucleolus, two chromatin masses appear, one of which is larger than the other (Figs. 22–24). They are stained in the same manner as the ordinary chromosomes both with iron-hæmatoxylin and with AUERBACH'S method, a fact which induces one to think that these bodies may be XY-chromosomes which exist in this stage as the chromosome nucleoli.

The nucleolus grows rapidly till it finally attains its maximum size at the end of this stage (Figs. 23–25). At the beginning of this stage the idiozome can clearly be seen, usually situated in close contact with the the nuclear membrane (Figs. 132–134).

1. This stage probably corresponds to the diffuse or confused period described by WILSON ('12). In some insects the diplotène-nuclei undergo remarkable transformation in which double threads completely disappear from view, giving rise to a diffuse, lightly staining net-like nuclei.

At about the same time the chromatoid body makes its appearance as a round body near the nuclear wall, being deeply stained with acid dyes and iron-hæmatoxylin (Figs. 21, 24). The mitochondrial granules appear abundantly in the cytoplasm, being scattered throughout the cell body. The granules are larger than those of the spermatogonia or the early spermatocyte (Fig. 26).

The late prophase:—The nuclei now undergo a remarkable transformation, characteristic in many animals, in the course of which the spiremes bebome more distinct and begin to shorten (Figs. 28, 29). Later on the spiremes shorten more and more until they assume long and curved rod-shape, and at the same time their staining capacity begins to increases rapidly (Figs. 30, 31, 136). Soon after various bivalent chromosomes appear which are characteristic in the mouse (Figs. 32, 33, 35). According to their characteristic form they are divided into the following two different types, namely : 1. The first type is the single ring which is formed by the union of two ends of the curved chromosomes. 2. The second type is the bivalent rod which consists of two short chromosomes. The first type can be seen only in large chromosomes, while the smaller ones belong to the second type. It is difficult to determine accurately in what manner the rings are formed. But from direct observation it seems most probable that they are formed not by separation of the longitudinal splitting which sometimes appears at the beginning of this stage in the preparation fixed with Champy's method.

When the nuclear membrane begins to disintegrate the chromosomes shorten progressively until they assume short rod-shape (Figs. 34–36).

The number of the bivalent chromosomes is obviously half of the diploid number.

At this stage the XY-chromosomes can not be identified. The absence of these chromosomes is probably due to the fact that in this stage they are united to form a bivalent chromosome.

Owing to its small size, in this stage, the nucleolus is not distinguishable with ordinary dyes (iron-hæmatoxylin), whereas with AUERBACH's method it can clearly be made out (Figs. 136, 137). At the beginning of this stage this body begins to disintegrate, leaving a small amount of chromatins behind, which is probably used up in the formation of the chromosomes (Figs. 135,

136). Soon after this body gradually diminishes in size, but being deeply stained with acid-fuchsin, it can usually be seen until the time of the disappearance of the nuclear wall (Fig. 138). When the nuclear membrane begins to disintegrate, the nucleolus except in some rare cases, can not be seen (Figs. 37, 38).

The mitochondrial granules, are now considerably increased in number as compared with previous stages (Fig. 26). At the late prophase when the nuclear wall begins to disappear, the idiozome completely disappears, but the chromatoid body can sometimes be seen clearly in the cytoplasm.

B. The growth period of the spermatocyte of the rabbit.

The resting stage:—The resting spermatocytes are found always in contact with spermatogonia arranged directly within the wall of the tubule. The nuclei usually contain, like those of the resting spermatogonial cells, many chromatin masses and several nucleoli (Fig. 146). Regarding the chromatin nucleolus, no phenomenon of dimorphism is to be observed in this stage.

The leptotène stage:—The chromatins soon condense into apparently continuous, slender filaments (Fig. 96). These immediately begin to converge to one pole of the nucleus where the idiozome is situated. During this stage the chromatin threads become arranged in a tangled mass, but no parallel arrangement can be seen (Fig. 96).

The synaptic stage:—Following upon the leptotène stage comes the synaptic stage. As in the horse the leptotène threads become aggregated at one pole of the nucleus where the idiozome is situated (Fig. 97). Finally the spiremes are gathered together and form a mass, but, by careful observation, their individuality can clearly be made out (Fig. 98). With the aggregation of the chromatin spiremes the nuclear wall expands rapidly, leaving a clear space on the other side of the nucleus (Fig. 97–99). At the end of this stage the parallel arrangement of the spiremes can very often be seen. The whole mass of the chromatin threads begins to move towards the center of the nucleus, the clear space thus gradually disappearing, while the nuclear wall becomes spherical (Figs. 99, 100).

As in the guinea-pig described by DUESBERG ('11) the mitochondrial

granules appear in small numbers which are usually gathered near the idiozome (Figs. 98, 99).

The pachytène stage:—The number of spiremes is considerably reduced, appearing about half of the original number and fully twice as many as those of the leptotène stage (Fig. 100). The movement of the chromatin spiremes are carried out further until they spread throughout the nucleus, while the cell gradually increases in size and the nuclear wall is more clearly defined (Figs. 101, 148). In this stage two or more small spherical nucleoli appear, which can clearly be seen in the section stained with AUERBACH's method (Fig. 148).

The diplotène stage:—The cells rapidly grow in this stage, becoming twice as large as in the leptotène stage, and the spiremes stain faintly with iron-hæmatoxylin, and show a granular appearance (Fig. 101). Together with the growth of the cell the spiremes become thicker, and in some spiremes the longitudinal splitting appears distinctly in any preparation (Figs. 102, 103). The spiremes shorten more and more until the various bivalent chromosomes appear (Fig. 104).

As in the mouse in this stage the spiremes increase the affinity for acid fuchsin, which proceeds parallel with the growth of cells, attaining its maximum at the end of this stage (Fig. 150).

The nucleolus is conspicuous throughout this stage, and attains its greatest size at the end of this stage (Figs. 149, 150). As in the mouse the chromatoid body appears at the beginning of this stage, being stained like the nucleoli (Fgis. 102, 105, 150).

During this stage the chromosome nucleolus which corresponds exactly with that of the horse can be clearly seen (Figs. 101–103, 150).

The prophase:—Finally the spiremes become shortened in length and form many variously curved chromosomes, but the forms of the bivalent chromosomes are different from those of the mouse (Fig. 105). In some chromosomes the longitudinal splittings are very conspicuous, and form large slits in the chromosomes (Fig. 104). Thus the ring-shaped chromosomes appear, while in most of the smaller chromosomes the longitudinal splitting does not appear at all but the chromosomes appear as bivalent rods (Fig. 105).

Among the bivalent chromosomes a short, large chromosome appears which may be the accessory one (Figs. 105, 106). At the end of this stage this body can not be made out, as every chromosome now becomes shortened and the bivalent form almost disappears.

In this stage it is not difficult to distinguish each chromosome and so to count their number, as the chromosomes are distinctly separated (Figs. 104, 105). For counting the chromosomes, only those cells were selected in which the chromosomes are well separated. It was found that all such cells always contain twenty four chromosomes. Thus it is certain that the reduced number of chromosomes in the male germ cells is twenty four, accordingly the spermatogonial chromosomes are probably forty seven in number, consisting of forty six univalent chromosomes and an odd one.

The nucleolus usually disappears at the beginning of this stage, but sometimes it still remains till the end of this stage. In every stage it can clearly be discerned by its distinctive staining capacity with AUERBACH's method (Figs. 149, 150). The behavior of the mitochondrial granules and idiozome are entirely similar to that of the mouse.

III. THE REDUCTION DIISION.

A. The reduction division in the mouse.

The first reduction division:—In the polar view of the equatorial plate of the metaphase the chromosomes are distinctly separated and so it is not difficult to make out every chromosome and to count them exactly (Figs. 37–41). In the early metaphase the characteristic form of the tetrad still appears, showing distinct and constant differences in size and form (Figs. 37, 38). In most of the metaphase the number of the chromosomes is always counted to be twenty which represents half the number of the chromosomes of the spermatogonia (Figs. 37, 41). When the chromosomes are compared according to their size it is found that, even though they form a series differing very gradually from the largest to the smallest, they can be classified in three groups; namely, three large sized, fifteen middle sized and two small sized ones (Figs. 38, 40, 41). If we compare the series of the spermatogonial chromosomes with that of the haploid ones, we can clearly recognize that the

bivalent chromosomes are formed by the conjugation of the homologous ones (Figs. 9-13).

The side view of the metaphase plate of the first division shows that twenty bivalent chromosomes are arranged in the equatorial plate with their short axis parallel to the latter (Figs. 43–45). Immediately they begin to divide at their ends where the spindle fibers attach (Figs. 46, 47). Whether this dividing line of the chromosome represents the conjugated plane of the univalent chromosomes or whether it is simply the longitudinal splitting which is comparable to that of the somatic chromosome, is difficult to determine positively. But judging from the method of synapsis and from the ring formation, this line of division seems to be equivalent to the conjugated plane of the univalent chromosomes. If it is so, then the division must be looked upon as a reducing one.

When every chromosome is simultaneously divided into two portions U- or V-shaped ones are not produced, but they simply assume the short rod-shape (Fig. 51). In well stained preparations previously treated with a modification of HANCE's method, two special chromosomes with different behavior can usually be seen at this period. These may be the sex-chromosomes and consist of a large X- and a small Y-chromosome. In the metaphase these XY-chromosomes are united to form a bivalent one, appearing as an ordinary bivalent chromosome. Together with the division of the ordinary chromosomes the bivalent sex-chromosome usually separates into its components, a large X and a small Y-chromosome, these are usually seen at the beginning of the anaphase, but they can often be seen at the late metaphase as well (Fig. 46-51). In the metaphase these chromosomes are sometimes seen near the respective poles, while the ordinary ones still remain in the equatorial plate (Fig. 48). This shows that the division or the separation of the bivalent sex-chromosome precedes that of the ordinary ones and its components X and Y pass to the respective poles in advance of the latter.

When the chromosomes arrive at the respective poles they are usually separated and so it is not difficult to make out their individualities. In a good polar view of the anaphase we can distinguish two kinds of groups of chromosomes, the one containing the large X-chromosome and the other the small Y (Fig. 13). If we now pick out all the chromosomes and arrange

them carefully in accordance with their form and size, it will be plainly shown that they are represented by pairs, with the exception of the sex-chromosomes (Fig. 13). In the telophase all the chromosomes become so closely aggregated that their individual outlines are entirely lost to view.

The second reduction division:—In the second reduction division the chromosomes have a tendency to gather into a mass, which makes it difficult to count them with certainty. In fairly good stained preparations the number of chromosomes is estimated to be twenty, but the sex-chromosomes can not be clearly distinguished (Figs. 59–62).

As in the case of the horse and cattle the second pairing of the chromosomes reported by GUYER ('10), JORDAN ('12) and WODSEDALEK ('13, '14, '20) could not be seen. It has also been recently denied by HANCE ('17) in the pig and by ALLEN ('18) in the rat. It is very likely that such an apparent pairing of the chromosomes is produced as the result of a poor fixation of the material in which the chromosomes are massed together.

In the equator of this division all the chromosomes become so placed that the transverse constriction of each of them coincides with the equatorial plate, and it is along this plane that they are divided at the same time, no special chromosomes with different behavior being seen among them (Figs. 62–64). This constriction of the chromosome represents the longitudinal splitting which is comparable to that of the somatic chromosome. If it is so, it will be conjectured that the real character of the second division is simply an equation division, the sex-chromosomes being also divided into two by the longitudinal splitting like the ordinary ones. As in the first division, in the anaphase of this division the chromosomes are distinctly separated and for a short time maintain their individualities (Fig. 65). In the telophase the chromosomes also gather together so closely that their individualities become entirely lost to view (Fig. 66).

The mitochondria:—During the first reduction division the mitochondrial granules lie outside the spindle, being scattered throughout the cell body (Fig. 42). Sometimes linear arrangement of them is to be seen in this stage (Fig. 42). When the cells divide into two, they remain undivided and seem to be equally distributed in the cytoplasm of the daughter cells. In the first division most of the granules seem to attain their greatest size, but it is

difficult to determine this with any certainty since their size is too small to measure. In the second reduction division the mitochondria repeat the same behavior as in the first (Fig. 63).

The chromatoid body:—During the first division the chromatoid body usually lies near the pole of the spindle (Fig. 43). At the telophase it remains without division and enters into one of the daughter cells. Sometimes beside the chromatoid body a large round body appears which is stained deeply with acid-fuchsin like the chromatoid body (Fig. 45). In the succeeding stage this body can not be distinguished from the chromatoid body. Judging from the behavior and situation this body is probably the remnant of the nucleolus which appears in the early metaphase, but it is uncertain whether it remains till the transformation of the spermatid as the true chromatoid body, or disappears in the telophase of the first division. In the second spermatocyte the chromatoid body is very conspicuous and is probably the same as that seen in the telophase of the first division. In the second reduction division the chromatoid body repeats the same behavior as in the first, but in the telophase it lies near the cell plate (Figs. 62–64, 66, 141). When the cell is divided into two the chromatoid body enters into one of the daughter cells (Fig. 142). Sometimes some extra small bodies appear which are probably produced by division of the chromatoid body.

It is remarkable that in the second spermatocyte the chromatoid body becomes more conspicuous and is deeply stained with acid-fuchsin (Figs. 141, 142).

The resting stage of the secondary spermatocyte:—As in other mammals the resting stage of the secondary spermatocyte is found in the mouse. The nuclei of the resting secondary spermatocytes contain several chromatin masses and no special chromosome nucleoli can be found. The idiozome, the chromatoid body and the mitochondrial granules appear in this stage, the latter being scattered throughout the cytoplasm.

B. The reduction division in the rabbit.

The first reduction division:—In the metaphase of the first reduction division the chromosomes have a tendency to mass together so closely that it is difficult to make out their individualities distinctly (Fig. 108). That thsi

aggregation of the chromosomes in the first division is to be regarded as the natural state of the chromosomes at this stage and not due to the influence of the fixation may be concluded from the fact that the diploid chromosomes occuring in the same tubule are distinctly separated from each other. In a good polar view of the equatorial plate of the metaphase the number of the chromosomes is rather difficult to determine but may be counted as over twenty (Fig. 108).

In the equatorial plate of this division all the chromosomes, except the accessory one, become so placed that the constriction of every one of them coincides with the equatorial plate (Figs. 107, 108). The division begins to occur at this point of constriction where the spindle fiber attaches and soon the chromosomes become separated into their components (Fig. 109).

If this plane of division represents the line of the conjugation of two univalent chromosomes, then the conjugated univalent chromosomes must be separated and so the first division is the reducing division. When the chromosomes thus separated move towards the respective poles, U- or V-shaped ones can not be produced, they simply remain as short rod-shaped ones.

In the metaphase when the ordinary chromosomes begin to divide, the accessory passes undivided to one pole of the spindle in advance of the ordinary chromosomes and can easily be distinguished from the latter by its special form (Figs, 106, 107). Its behavior corresponds almost exactly with that of the other mammals. Even though we can not trace this chromosome as exactly as that in the horse and cattle, we need not hesitate to identify it with the same. When all the chromosomes arrive at the poles they are gathered so closely together that their individual outlines can not possibly be made out, the accessory at the same time disappearing from view (Fig. 110).

The second reduction division :—As in the first division, so in the second division the chromosomes have a tendency to gather into a mass so closely together that it is difficult to distinguish every chromosome and so to count them (Fig. 112). In this division all the chromosomes are so arranged that their transverse constrictions which probably represent the longitudinal splitting, coincide with the equatorial plate, and thus they begin to divide into two portions by the separation of the daughter chromosomes at the

constrictions, the accessory being divided into two at the same time (Figs. 111, 112). If this view be right, and we have reason to think it so, the second division is simply an ordinary mitosis.

At the anaphase when the chromosomes arrive at the poles they are as usual gathered together into a mass, and it is difficult to distinguish their individualities (Figs. 114, 115).

The mitochondria:—In the metaphase of the first reduction division the mitchondrial granules lie outside the spindle, being scattered all over the cell body. At the anaphase they remain undivided, but after the division the granules seem to be approximately equally distributed in the daughter cells. In the resting secondary spermatocyte they are also seen scattered all over the cell. In the second reduction division they repeat the same behavior as in the first division.

Even though the amount of the mitochondrial granules vary considerably according to the stage, it is clear that they are of very small number compared with those of the mouse. As in the mouse the size of the granules is variable, not only in the cells of different stages but also in those of the same stage.

The chromatoid body:—In the first reduction division the chromatoid body like that which we found in the mouse rarely appears (Fig. 110), this is also the case in the secondary spermatocyte (Fig. 111).

The resting stage of the secondary spermatocyte:—The nuclei of the resting secondary spermatocytes contain several chromatin masses; and no special chromatin nucleolus can be found among them.

IV. The Spermatids up to the Formation of the Spermatozoa.

A. Spermatid in the mouse.

Immediately after the second division, the chromosomes begin to break up and the nucleus enters the resting stage (Fig. 143). The resting nucleus of the spermatid usually contains several chromatin masses and a few chromatin granules which are scattered along the linin threads (Fig. 143). The chromatins are gradually gathered together in the center of the nucleus where the nucleolus is situated (Figs. 67, 68, 144). The nucleolus can

clearly be seen with AUERBACH's method, while with iron-hæmatoxylin this appears as a chromatin nucleolus. Thus the dimorphism as regards to the existence of the chromatin nucleolus, can not be seen.

In the cytoplasm the chromatoid body or "chromatoider Nebenkörper" is always conspicuous, stained deeply with acid-fuchsin by AUERBACH's method, while with iron-hæmatoxylin it is difficult to find the distinction between this body and the chromatin mass (Figs. 67, 143).

The centrosome can clearly be seen in this stage, usually lying near the nuclear wall (Fig. 67). At the beginning of this stage the idiozome distinctly appears in close contact with nuclear wall, showing a sharp contour (Figs 68, 143). As has already been described by BENDA ('91) and by MEVES ('99) small granules can be seen within the idiozome (Fig. 67, 68). A small quantity of the mitochondrial granules appears in this stage, being distributed all over the cell body (Fig. 69).

B. The formation of the spermatozoa in the mouse.

PERIOD[1] I.

The nucleus:—The small spheric nucleus gradually enlarges and the chromatin granules begin to disappear, leaving a central mass of chromatin behind (Fig. 67–70). This enlargement of the nucleus is probably due to the fact that at this stage the spherical nucleus begins to flatten. Simultaneously with this the nucleus gradually moves towards one side of the cell which is destined to become the anterior end of the spermatozoön, while a large amount of the cytoplasm accumulates at the posterior part of the cell body (Figs. 70, 71).

The centrosome:—In this period two centrosomes become clearly visible; these lie at first side by side, but soon move towards the nuclear wall (Figs. 69, 70). One of these centrosomes which is destined to become the anterior one, comes to be placed in contact with the nuclear wall, while the fine filament which later becomes the axial filament of the spermatozoön, begins

1. The four periods into which the formation of the spermatozoa is divided, is in accordance with the work of MEVES ('99), although it is not possible to draw any definite line of demarcation between the two successive periods.

to proceed from the posterior one backward towards the surface of the cell (Figs. 69–71).

The idiozome :—Later on the granules of the idiozome gradually grow and these collect together and form a large mass which usually lies close to the wall of the idiozome, being surrounded by a clear space (Figs. 67–69). When the two centrosomes appear this mass is found to lie in close contact to the anterior part of the nuclear wall where a slight depression appears, while the remnant of the idiozome in which vacuole can be seen, gradually diminishes in size, becoming more and more homogeneous (Figs. 69–81).

The mitochondria :—A small number of the mitochondrial granules still remains in the cell body, the main portion of them being gathered at the posterior part of it (Fig. 69).

The chromatoid body :—The chromatoid body remains without any change and usually lies near the centrosome, appearing as a spheric body (Fig. 70).

Period II.

The nucleus :—At the beginning of this period the nucleus begins to elongate and finally assumes a pear-shape (Fig. 72). Some of the chromatin granules begin to collect on the inner surface of the nucleus, while several masses are left behind, and are so faintly stained with iron-hæmatoxylin, that the nucleus appears more or less homogeneous (Figs. 72–74).

The centrosome :—The anterior centrosome which is situated on the nuclear wall, gradually grows and flattens, while the axial filament elongates more and more until it proceeds backwards and projects out of the cell body (Figs. 72–74).

The acrosome :—The acrosome which is formed by the condensation of the granules of the idiozome now grows and flattens, to spread out finally on the anterior surface of the nuclear wall, while the remnant of the idiozome gradually diminishes in size (Figs. 72–74).

"Schwanzmanschette" :—At the end of this stage the "Schwanzmanschette" appears at the posterior part of the nuclear wall (Fig. 72). Its form is entirely similar to that of the guinea-pig, as described by Meves ('99), but the filamentous structure as indicated by him can not be seen.

Within the "Schwanzmanschette" the centrosomes, the axial filament and the "chromatoider Nebenkkörper" are enclosed, the latter having attained the greatest size at the beginning af this stage (Figs. 72–74).

The mitochondrial granules:—The mitochondrial granules are scattered throughout the cell body and again increase in number (Figs. 72–74).

PERIOD III.

The nucleus:—The nucleus continues to elongate until its anterior part begins to bend towards one side which is destined to become a ventral part of the spermatozoa (Fig. 75). At this stage all the chromatin masses entirely disappear, and the nucleus thus becomes homogeneous, but takes a deep methyl-green stain with AUERBACH's method (Fig. 75) From this fact it seems more probable that the chromatin masses break into very small particles and are distributed throughout the nucleus, the main portion of these particles being condensed at the nuclear wall. At the post-ventral side of the nuclear wall a large depression appears where the centrosome is situated (Figs. 75–77).

The centrosomes:—The posterior centrosome begins to divide into two, while the anterior one comes to be placed in close contact to the nuclear wall (Figs. 75, 76). Of these two centrosomes thus formed by division of the posterior one, the smaller one is placed nearer the nucleus, while the other is placed outside it. The smaller one retains its spherical shape, and has the axial filament attached to it. The larger centrosome now assumes a ring shape and gradually increases in size, while the axial filament comes to pass through the ring (Fig. 75, 77). Soon after the ring-shaped centrosome begins to move backward along the axial filament (Fig. 78).

The mitochondrial granules:—The mitochondrial granules are now gathered into several groups within the elongated cell body, and these soon begin to arrange themselves around the axial filament (Figs. 77, 78). Besides the mitochondria other large granules can be seen, stained deeply with osmic acid (Fig. 83). These may be fat-granules which probably correspond to those of the rat, as described by DUESBERG ('08 b).

The acrosome:—The acrosome assumes a pear-shape and attaches at the apex of the head of the spermatozoa, while the rest of the idiozome completely disappears (Figs. 75–78).

"Schwanzmanschette" and "chromatoider Nebenkörper":—When the ring-centrosome begins to move backward, the "Schwanzmanschette" gradually disappears (Figs. 77, 78). The fate of this membrane could not be determined, but it seems probable that, as HERMANN ('98) long ago described, this membrane is of use for the development of the middle piece of the spermatozoa.

The "chromatoider Nebenkörper" is always placed within the "Schwanzmanschette" during this period, diminishing gradually in size till it finally disappears.

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The nucleus is somewhat elongated, becoming homogeneous in appearance (Figs. 80, 81, 84). Together with this, the mitochondrial granules gradually collect around the axial filament, and arrange themselves spirally around it, the extreme end of the granules being marked by the presence of the ring-shaped centrosome situated on the posterior end of the cell (Figs. 80, 81, 84). At the beginning of this period the anterior centrosome becomes divided into two in the direction along the surface of the nuclear wall, but still connected with each other by a fine intervening fibre, and thus forming an elongated dumbbell-shaped body lying close on the wall of the nucleus. Each of the two ends of this body is now seen to be connected with the posterior centrosome by a fine fibre (Figs. 80, 84). During these changes the cell body becomes considerably elongated while its contents, including all the fat-granules, is cast off as a cytoplasmic ball out of the spermatozoön, leaving only the axial filament and the mitochondrial granules which now assume a beautiful spiral shape (Fig. 84).

C. The spermatid of the rabbit.

As in the mouse the resting nuclei of the spermatids usually contain many chromatin granules and a large irregular chromatin mass which lies usually at the center of the nucleus (Figs. 116, 150). Besides the latter a nucleolus can be seen in the preparation stained with AUERBACH's method (Fig. 150).

In the cytoplasm the idiozome is conspicuous, while the chromatoid body can not be found in most of the cells. But a very small body which is

probably a portion of the chromatoid body sometimes appears (Figs. 116, 119). A few mitochondrial granules appear, most of them lying near the cell wall (Fig. 116).

D. The formation of the spermatozoa in the rabbit.

As the transformation of the spermatid in the rabbit, with the exception of the centrosome and of the mitochondria, is almost similar to that of the mouse, we will chiefly consider the changes of the centrosome and the development of the middle piece of the spermatozoa.

When the granules of the idiozome collect into a large single mass and become attached to the anterior part of the nuclear wall, two centrosomes become clearly visible (Fig. 118). Of these the one which is destined to become the anterior centrosome, comes to lie close to the nuclear wall and grows rapidly, while the other assumes for a while its original position (Fig. 119). This latter now begins to send out a fine filament which recedes backwards toward the surface of the cell (Fig. 119).

This period thus corresponds exactly to the period I in the mouse. The anterior centrosome gradually grows larger and divides into two, lying side by side close to the posterior wall of the nucleus (Figs. 120, 121). Soon after the posterior one also divides into two, and the four centrosomes thus formed are connected with each other by fine filaments (Fig. 121). Together with these changes of the centrosomes the axial filament elongates more and more until it proceeds backwards and comes to project outside of the cell body.

The chromatoid body which was rarely found at the cell wall in the previous stage, entirely disappears in this stage.

The "Schwanzmanschette" which, as in the mouse, begins to appear with the elongation of the nucleus, becomes gradually smaller, when the four centrosomes are formed, till it finally disappears (Figs. 121–123).

Now the posterior two centrosomes gradually increase in size, becoming more conspicuous in the final development of the spermatozoa (Figs. 124, 125). The ring shaped centrosome found in the mouse and the other mammals could not be seen at all.

At the time when the two primary centrosomes become distinctly visible, a small number of the mitochondrial granules still remains near the cell wall,

which in a later stage seem to increase (Figs. 119, 120). The augmentation of them in this period was reported by DUESBERG ('08 b) in the rat and by JORDAN ('12) in opossum.

Later on the main portion of the cytoplasm moves backwards, assuming a rounded body, and comes to be placed entirely in front of the nucleus which now becomes more and more elongated, till it finally assumes its position as the head of ripe spermatozoön (Figs. 121, 123). During these changes the mitochondrial granules gradually collect in several groups and finally become arranged around the axial filament, while the "Schwanzmanschette" entirely disappears (Figs. 122–123).

In the middle piece of the ripe spermatozoa found in the tubule, about twenty four large granules can be counted arranged in two rows along the side of the axial filament (Figs. 124–125). From what is stated above it is clear that these granules are formed by the aggregation of the small mitochondrial granules.

General Considerations.

I. THE CHROMOSOMES OF THE SPERMATOGONIA.

Number of chromosomes in rodents:—As to the number of chromosomes in the rodents there is a wide difference in opinion among the investigators.

In the maturation of the egg of the mouse, SOBOTTA ('95) and KIRKHAM ('07) reported twelve chromosomes, while LONG and MARK ('11) counted twenty chromosomes, in both the maturation divisions. YOCUM ('17) reported twenty chromosomes as the reduced number in the male germ cells of the mouse.

But, as far as I am aware, none af the investigators gave the positive diploid number of chromosomes in the mouse. In the rat DUESBERG ('08 a) reported twelve chromosomes as the reduced number. Recently ALLEN ('18) has counted thirty seven chromosomes in the spermatogonia of the rat, nineteen in the first reduction division.

In the rabbit WINIWARTER ('00) found that the somatic chromosomes vary from thirty six to eighty. BACHHUBER ('16) reported twenty two chromosomes as the diploid number and twelve as the reduced number in the male germ cells of the rabbit. STEVENS ('11) counted fifty six chromosomes in the

spermatogonia of the guinea-pig and he concluded that this number is probably correct.

The existence of pairs of chromosomes :—Since the chromosomes of the mouse are of large number and vary so gradually in size, that it is difficult to determine them accurately by only cursory observations, especially the existence of the pairs among the chromosomes and the constant relation with regard to their size and form are the points which require a thorough and careful study.

For the determination of the existence of the pairs among somatic chromosomes, measurements have been made by some investigators. MEVES ('11) in salamander, HANCE (,17) in the pig and Parmenter ('19) in some Amphibia (Amblystoma) measured the length of the chromosomes, while KATSUKI ('19) in silkworm measured the diameter and calculated the volume.

In the mouse it is difficult to determine the existence of the pairs of chromosomes by the comparison of their length only, as they are not straight but of various shapes. Nevertheless, if the size of every chromosome is constant in any definite period of the mitosis, and if it is possible to determine the true size of the chromosomes, it would be a very good method for the determination of the presence of the pairs, but it is very difficult to determine since the shapes of the chromosomes vary so very much.

As before stated, the writer therefore, tried to find out the paired chromosomes, basing the determination on their shape and size, as he thought that this would give more trustworthy results than either by calculating the length or the breadth only (pp. 211). Three things must, however, be considered in this method: these are, 1. The difference in the degree of the condensation of the particles composing the chromosomes, which may cause slight differences in the relative size and form. 2. The small difference in size between neighbouring chromosomes in the series of the chromosomes arranged according to the size makes it sometimes impossible to demonstrate beyond all doubt the presence of pairs among them. 3. It is possible that an error may occur when the chromosomes are drawn with the aid of a camera-lucida.

In spite of these considerations, it will be seen from Table II where the chromosomes are arranged according to their area, that the present method is a most reliable one, as it affords on the whole undeniable evidence that the chromo-

somes form a duplex series, even though from the above reason it can not be expected, that the homologous chromosomes will always be of the same size.

The relation between size of cells and that of chromosomes:—Moreover in Figs. 9–12 where the chromosomes are arranged in accordance to our present method, each of the homologous pairs is found to be almost similar in shape, so that we can fairly reach the conclusion that there exists a constant relation between their size and their form.

It has already been stated above that the size of the chromosomes seems to vary in accordance with those of the nuclei. This relation will be more readily understood from Text-fig. 1, where curve I indicates the relation of the size of chromosomes which are contained in the large cell, while curve II indicates that of the small ones. It is found that these two curves are almost parallel with one another. Judging from this fact it is evident that the size of cells as well as that of the chromosomes vary considerably according to the generation of the spermatogonia, the chromosomes in early generations being probably larger than those in the final generation.

The sex chromosomes:—It is remarkable that there are two different chromosomes which have no mate. One of them is larger than the other, and differs considerably in form from the neighbouring chromosomes of the series, while the other is the smallest one of the entire series.

The difference in size between this smallest chromosome and the neighbouring one is considerably larger in comparison with that occurring between our other pairs. The above data shows conclusively that these special chromosomes are XY-chromosomes.

The fragmentation of the chromosomes in rabbit:—As stated above the number of chromosomes in the germ cell of the rabbit is not constant but varies considerably. Vom Rath ('94) long ago found that the somatic chromosomes in the dog vary considerably. The same phenomenon was reported by Winiwarter ('00) in the somatic cells of the rabbit. Hance ('17 b) found that the number of chromosomes of the somatic cells in the pig is not constant but varies from forty to forty seven. He attributed cause of this variation in number to the fragmentation of certain chromosomes, and says: "Since the fragments are fairly uniform in length, the chromosomes must be educed by more or less equivalent amounts, and consequently we should not

expect to find the percentage relation between the pairs showing any marked variation from that found between the spermatogonial pairs."

But as stated above the observation of the chromosomes of the spermatogonia in the rabbit compelled us to recognize the following facts: 1. Certain chromosomes are considerably long and variously curved, and sometimes show constrictions. 2. In those cells in which a large number of chromosomes are found, the smaller ones are very numerous.

From these facts it is conceivable that as HANCE ('17 b) has stated of the somatic cells of the pig, the cause of their variation is probably due to the fragmentation of certain chromosomes. But it is very probable that this fragmentation is not to be looked upon as a normal process occurring in the spermatogonia but is due to the influence of fixation. A striking evidence in support of this view is that, in materials which were poorly fixed, the variation in number of chromosomes was especially more numerous tnan in those which were better fixed.

II. THE SYNIZESIS AND THE SYNAPSIS.

The synizesis:—As mentioned above the slight polar aggregation of the chromatin threads can always be seen in the early stage of the spermatocyte in the mouse, while in the rabbit this aggregation is very conspicuous.

It ts, however, difficult to determine whether this aggregation of the chromatin threads represents the normal state which occurs in the cycle of the spermatogenesis and is comparable to that of the horse and of cattle where the conjugation of the chromosomes may occur, or whether this is regarded as an artifact, being probably the result of the fixation. DUESBERG ('08 a) holds the latter view, where he says: "On peut aller plus loin et faire remarquer que, si dans un matériel bien fixé on n'observe pas de retractione de la chromatine, cet argument negatif a une beaucoup grande valeur que l'argument positif contraire; car, s'il est impossible de mettre sur le compte des reactifs l'absence de synapsis, nous savons au contraire que les fixateurs, même les meilleurs, peuvent dans de mauvaises conditions, produire le synapsis."

1. In insects (Hemiptera), WILSON ('12) has stated that the contraction figure can not be regarded as an artifact. He proved that in some hemiptera this phenomenon is seen in the living cell.

HANCE ('17 a) also made a similar observation in the mammalian tissues, He says: "Synizesis was not seen in this material except in the center of a piece of tissue which was rather larger and where the fixative had not penetrated." Thus he attributes the cause of the polarization of the spiremes to the result of imperfect fixation of tissues. Again he says: "Even here it is not the tight ball of threads figured so many but gives every evidence that it is the result of the extraction of the fluid. In many preparations where any evidence of the synizesis of thin chromatin threads occurs, there is only a slight contraction if the threads away from the nuclear wall appearing as though the fluid which had supported these threads had been removed. The shrinkage appears to be equal from all sides, although occasionally a cell is found with the chromatin threads massed at one side. In well teased or small piece of tissue these same stages appear with the threads well separated and there is no shrinkage away from the nuclear wall."

But in my materials the observation of the preparations compelled us to admit the following facts: 1. Whatever fixations may be used, the synizesis (contraction figure) can be seen in every part of the sections, though it is very slight in the mouse. 2. This phenomenon occurs in the definite period of the growth stage of the spermatocyte, and in very young stage, but never in other stages. 3. At the end of this stage, the chromatin spiremes appear in about half the original number and twice as thick as the leptotène stage.

Judging from these facts it seems most probable that the polar aggregation of the chromatin threads in the rabbit and in the mouse represents the normal state which occurs in the definite period of the spermatocyte and corresponds to that of the other mammals. Moreover it is a striking evidence in support of this view, that in the rabbit, throughout the wall of the tubule in which the cells are presenting the synapsis, the parallel arrangements of the chromatin threads, without exception, show a decided contraction of the threads.

As I have stated of the horse in the previous paper ('19), the leptotène threads in the rabbit are aggregated to one pole of the nucleus where the idiozome is situated. The same phenomenon was described by WODSEDALEK ('13) in the pig and JORDAN ('12) in opossum. MORSE ('09) found a similar condition of the condensation of the chromatin threads in the spermatocyte

of certain cockroaches and came to the conclusion that it is due to some interaction between the chromatin spiremes and the centrosomes which gives rise to this phenomenon. BUCHNER ('10) more fully demonstrated the relation of the centrosome and other substances of the cell (nuclear as well as cytoplasmic substance), where he says; "Das Centriol vermag Körper in Kern und im Plasma anzuziehen und vermag ferner die Kernmembran in seiner Nachbarschaft aufzulösen."

The synapsis:—As already described, in the mouse there is no indication of parasynapsis in this stage, while in the rabbit parallel arrangement of two univalent spiremes is seen to occur, which exactly corresponds with that of the horse,

In the rat ALLEN ('18) has shown the parasynapsis, but he did not indicate the parallel arrangement of the spiremes in this stage.

Only from observation of the spiremes in this stage have we reached the view that the method of synapsis in the mouse is different from that in the former the conjugation probably taking place by telosynapsis but in the latter by parasynapsis.

Nevertheless, in order to completely consider the question of the synapsis there are two significant facts which demand careful observation. The one is the transformation of chromatin spiremes in the post-synaptic stage and the other is the construction of chromosomes in the late prophase. In the post-synaptic stage the longitudinal splitting of the chromatin spiremes can usually be seen in the rabbit and also in the mouse. Whether the longitudinal splitting of the chromatin spireme is entirely the same as that of the somatic chromosomes, or whether this splitting is the result of the conjugation of the univalent chromosomes, is the most significant point in the determination of the method of the synapsis. The former view was maintained by GOLDSCHMIDT ('08), by FICK ('08), DUESBERG ('08 a), BUCHNER ('09) and by JORDAN ('12), whereas WILSON ('12) holds the latter view. By careful observations in the mouse, as already described, it is found that the ring-shaped chromosomes are formed by the union of the two ends of the conjugated univalent spiremes. Soon after the rings are closed up and the metaphase chromosomes appear. The longitudinal cleft of the chromosome which appear in the early metaphase (Fig. 36) must therefore be looked upon as a conjugated plane of the two univalent chromosomes.

These facts lead us to the conclusion that in the mouse the conjugation of chromosomes may occur by telosynapsis.

In the rabbit the ring shaped chromosomes appear to be formed by the separation of the univalent chromosomes along the plane of a longitudinal splitting. It has, however, been found that this, in fact, is not the case, the splitting seen in the chromosomes probably represents the line of conjugation of the univalent chromosomes, since the splitting appears only in the special chromosomes. From these facts it is more probable that the conjugation of the chromosomes in the rabbit takes place by parasynapsis.

Although the method of synapsis in the mouse is different from that in the rabbit, in both these animals, the conjugated chromosomes become disjointed. Thus by whatever method of the synapsis the conjugation of chromosomes may occur, it will come to the same result as regards the reduction of the chromosomes.

III. The Sex-Chromosomes and the Nucleolus.

The sex-chromosomes:—As far as I am aware, sex-chromosomes in the rodents were first recorded by Stevens ('12) in the guinea-pig. This was followed by Jordan ('14) in the mouse, by Bachhuber ('16) in the rabbit and by Allen ('18) in the rat.

Jordan ('14) in the white mouse found the double nature of the heterochromosome which suggests a pair of idiochromosomes, but he believed this to be a double accessory chromosome or Wilson's X-chromosome. In the rabbit he found that heterochromosomes are wanting in the spermatocyte of the growth stage. In the male germ cell of the mouse Yocum ('17) found the accessory chromosome which does not divide in the primary division, but does so in the secondary. As stated above in almost every stage of the spermatogenesis in the mouse XY- or idochromosomes usually appear which correspond almost exactly with those of the insects (Wilson) and the guinea-pig (Stevens).

In the rabbit the accessory or the X-chromosome can be seen in the growth period of the spermatocyte and in the reduction division, but the occurrence of the dimorphism of the spermatozoa as regards to the existence of this chromosome can not practically be determined.

From the observation of the spermatogonial chromosomes as well as those of the first reduction in the mouse, it is conceivable that with regards to the sex chromosomes dimorphism must exist among the spermatozoa and so a difference may exist between the chromosomes of male germ cells and of the female.

The nucleolus:—In the spermatocyte of the mouse a single large nucleolus appears while in the rabbit two or more can be seen. These can not be distinguished from the chromosomes in the preparation stained with iron-haematoxylin, while with AUERBACH's method these can clearly be made out.

The existence of the nucleolus in the spermatocyte has been reported by many investigators in several kinds of animals. In mammals it is described by STEVENS ('11), DUESBERG ('08 a), JORDAN ('14) and ALLEN ('18). All these investigators, with exception of JORDAN ('14), agree that the nucleolus appears at the post-synaptic stage and disappears in the prophase of the first maturation division.

JORDAN ('14) believed that in mammals the nucleoli almost invariably disappear before the synapsis and can thus produce no confusion with the heterochromosomes in those stages where the latter are most conspicuous.

As to the physiological meaning of the nucleoli of the germ cells, WILSON ('19) in accordance with HACKER's ('99) interpretation stated that, "the nucleoli of the germ cells are, in some cases at least, accumulation of by-products of the nuclear action, derived from the chromatin either by direct transformation of its substance, or as chemical cleavage-product or secretions.''

As stated above in the mouse and also in the rabbit the nucleoli appear at the post-synaptic stage and grow gradually, attaining its greatest size in the prophase. When the chromosomes become stained with methyl-green with AUERBACH's method, this body begins to diminish in size and finally disappears from view in the late prophase. Moreover it is a remarkable fact that when the growth of the cells attains to the maximum, the chromosomes and the nucleoli stain similarly with AUERBACH's method.

These facts force us to the conclusion that the nucleolus does not represent an accumulation of the by-products of the nuclear actions but consists of ground substance (plastin?) and nutritive substance? which is taken up by the nucleus from the cytoplasm; the latter probably used for the growth of the nucleus.

A similar view was propounded by MONTOGOMERY ('12) in his study on

Euschistus. He says: "In the spermatocyte they (plasmosomes) arise in close contact with the nuclear membrane, and at the same time in connection with the end of the autosome, which would suggest that the plasmosome is either the joint product of chromatin and cytoplasm, or else represents substance taken up by the nucleus from the cytoplasm."

IV. The Growth of the Chromatin Spireme.

In the prophase of the primary spermatocyte, together with the growth of the cell the chromatin spiremes grow considerably. At this stage they are stained faintly with iron-hæmatoxylin, while their affinity for acid-fuchsin gradually increases. A careful observation shows that this change of the staining capacity is due to the accumulation of the achromatic substance within the chromatin spiremes.

This change of the staining capacity proceeds with the growth of the cell body as well as that of the nucleus, until the bulk of the cell attains its greatest size. In the metaphase of the first reduction division the achromatic substance of the chromosome entirely disappears, and the chromosomes are stained deeply with methyl-green with Auerbach's method. From these facts it is most probable that the achromatic substance of the chromosome is used up for the chromatins in the prophase. A similar phenomenon has already been described by Bonnevie ('08). He says: "Während nach dem obigen das Wachstum der Chromosomen in einer Zunahme ihrer Chromatinsubstanz besteht, scheint die während der Prophase erfolgende Volumzunahme in einer durch Flüssigkeitaufnahme eingeleiteten Neubildung achromatischer Substanz zu bestehen, und zwar so, dass ihre Menge von der Grösse jedes Chromatinfadens bestimmt wird."

Moreover as to the structure of the chromosome his interpretation is as follows: "Die neu gebildete achromatische Substanz scheint durch eine innere Differenzierung der Chromosomen in ihrer Mitte angesammelt und von einer oberflächlich gelegenen Schicht chromatischer Substanz umgeben zu werden."

V. The Mitochondria.

The behavior of the mitochondrial granules in the mouse and the rabbit is, except in some points, entirely similar to that described by Duesberg ('11)

in the guinea-pig. He states: "Les observations, encore rares d'ailleurs, sur les chondriosomes des cellules séminales des Vertébrés, montrent que, si dans les classes inferieures (Amphibiens) il existe des chondriosomes de forme filamenteuse, la forme granuleuse pataît être la règle chez les Mammifères. Cette forme se maintient pendant les divisions de maturation: on observe lien, pendant la seconde division de cobaye, quelques chondriomites, mais la formation de chondriocontes reguliers, comme chez les Insectes, n'a pas encore été signalée jusqu'ici. Dans la spermatide des Mammifères, les mitochondries ne se condensent pas en corps homogène, comparable au Nebenkern, mais restent individualisées. Tous les observateurs sont d'accord sur leur sort final: elles forment une gaine, de structure variable, au filament axile du spermatozoide." As to the process of the arrangement of the mitochondrial granules around the axial filament of the spermatozoa, contrary to my observation, he states that "le processus de la formation de la gaine mitochondriale débute par consequent, chez le cobaye comme chez le rat, au voisinage de la tête." In my materials, on the other hand, the mitochondrial granules begin to arrange around the axial filament near the posterior cell wall.

With regard to the origin of the mitochondrial granules the opinions of the investigators do not agree, some (Goldschmidt, Buchner, Jordan) taking the view that these granules are formed by extrusion from the nucleus, while others (Meves, Duesberg) hold for the cytoplasmic origin. JORDAN ('12) in opossum, though could not directly observe the extrusion of the granules through the nuclear membrane, concluded that the mitochondrial granules originate from the nucleus. This is based upon the following facts: 1. Within and without the nucleus many granules appear which have a similar form and staining capacity to those of the mitochondrial granules. 2. In these cells one half of the periphery of the nucleus becomes surrounded by a compact mass of spherical or bivalent chromidia closely adhering to the nuclear wall. 3. The cell in this condition is characterised by the absence of chromatin particles within the nucleus. 4. The appearance of the chondriosomes in the cytoplasm is coincident with the disappearance of the chromidia on the nuclear membrane.

In my materials it is hard to make sure whether the mitochondrial granules arise from the cytoplasm or from the nucleus. Such granules as

those of the opossum can not be seen within or without the nucleus, but in the leptotène as well as the synaptic stages a small number of the mitochondrial granules usually appear in the cytoplasm. As DUESBERG ('11) stated it is true that in the synaptic stage most of the granules always appear near the pole of the nucleus where the chromatin spiremes converge, and that they slightly increase in number. But it can not be admitted that this increase in number of the granules is due to the extrusion of chromidial particles from the nucleus, for the nuclear wall appears distinctly, and neither the granules nor the particles can be found within or without the nucleus at the converging point of the chromatin threads. But from actual observation it is more probaole that the mitochondrial granules do not originate from the nucleus in the synaptic stage, they usually exist in the cytoplasm throughout every stage and increase by division of the original ones. A number of facts favourable for this view are to be seen in my materials, of which the following can be cited: 1. The mitochondrial granules are usually found in the spermatogonial cells. The same facts have been reported by DUESBERG ('11) in the guinea-pig and JORDAN ('12) in opossum. 2. The growth of every granule can clearly be seen in the prophase of the first division. 3. In th same cell the size of the granules varies considerably. 4. Lineal arrangement of the granules can sometimes be seen. 5. The number of the granules differs considerably in different stages of the cells.

The only difficulty which confronts us in the assumption of the cytoplasmic origin of the mitochondrial granules, is perhaps the fact that in the synaptic stage they are always gathered near the pole where the idiosome situated. But this difficulty may be interpreted as follows: By the enormous expansion of the nuclear wall at this stage, the cytoplasm becomes pushed towards the pole where the idiozome is situated, and with this the mitochondrial granules also move toward the same pole. This change of the position of the granules can, however, be ascribed to the attraction of the centrosomes as BUCHNER ('10) indicates.

VI. THE CHROMATOID BODY.

The chromatoid body was long ago described in mammals by many investigators (Meves, Hermann, Lenhossék, Niessig and Duesberg). Recently

it has been described by WODSEDALEK ('14) in the horse, BACHHUBER ('16) in the rabbit and ALLEN ('18) in the rat. In insects this body was accurately described by MONTGOMERY ('11) and WILSON ('13).

But its origin and function are still a question. It is already known that in the spermatid of the mouse (C. Niessig) and of the rat (Meves) this body is very conspicuous, while in the guinea-pig (Meves) it disappears at the beginning of the development of the spermatozoa. MEVES ('99) in the guinea-pig showed that the chromatoid body is stained as the nucleoli. He says: "Ich selbst habe von Färbungen, welche geeignet sind, über die Natur des chromatoiden Nebenkörpers Aufschluss zu geben, nur (nach Sublimatfixirung) die Ehrlich-Biondische Dreifachfärbung angewandt, bei der er sich ebenso wie die Nukleolen intensiv rot färbt; ich kann also jedenfalls Moore nicht beistimmen, dass es sich um eliminertes Chromatin handelt." DUESBERG ('11) also in the guinea-pig found the same phenomenon by using BENDA's method. ALLEN's ('18) observation in the rat is different from that of many other investigators as well as from mine. His description on its behavior and on its fate is as follows:" Its first positive appearance is in the late prophase stage of the first spermatocytes after the disappearance of the nuclear membrane. At first it appears to be near the chromosomes, but at a later stage it is always found well out in the cytoplasm. In some metaphase cells it is doubled. It is lost during the anaphase of the first spermatocytes and during the interkinasis stage, but reappears in the second spermatocytes. Nothing of equivalent form is found in the spermatids. In these cells, however, there is a mass lying near the nucleolus which stains like chromatin. It develops intensity of staining reactions as the spermatids advance in differentiation. In its fuller development it is as in figure 1, spermatid 3, where it appears as a globular body, but much larger and staining more deeply than the chromatoid body."

In my materials, as stated above, the chromatoid body is conspicuous from the prophase of the first division up to the transformation of the spermatids, and as MEVES ('99) and DUESBERG ('11) indicated, it stains deeply with acid-fuchsin with AUERBACH's method. As to the fate of this body there is a difference between the mouse and the rabbit.

In the mouse it remains near the centrosomes within the "Schwanzmanschette" during the development of the spermatozoa, while in the latter it

usually disappears during the second division. Moreover, it is obvious that when the cell is divided into two it enters into one of the daughter cells without division, which produces two kinds of the spermatids in the mouse, the one with and the other without the chromatoid body.

From these it seems more probable that the chromatoid body is not an essential organ for the development of spermatozoa. Although its origin can not be determined with any certainty, from the period of its appearance and its staining reaction it seems more probable that the chromatoid body is not a proper cytoplasmic structure but originates from the nucleus. Its chemical nature seems to be different from that of the chromatin granules but is similar to that of the nucleoli which appear at the growth period of the spermatocyte.

Summary.

I. Observation in the Mouse.

1. The resting nuclei of the spermatogonial cells usually contain one large nucleolus and several chromatin masses.

2. The number of spermatogonial chromosomes may be counted as forty. According to size and form, these are found to be in pairs. Every chromosome simultaneously begins to divide at one end where the spindle fiber attaches; no special chromosomes with different behavior are to be seen among them.

3. In the young spermatocyte a slight polar aggregation of the chromatin threads usually appears, which corresponds to the synizesis of other animals.

4. In the post-synaptic stage when the nucleolus appears the chromatin spiremes are stained with both methyl-green and acid-fuchsin at the same time with AUERBACH's method. Together with the growth of the cells and of the nucleoli, this change of staining capacity increases, attaining the maximum in the prophase stage in which the ring shaped chromosomes begin to appear. At the late prophase the chromosomes are again stained with methyl-green only. In this stage the nucleolus, except in some few cases, entirely disappears.

5. In the prophase several kinds of the ring shaped chromosomes appear which are condensed to the bivalent chromosomes in the metaphase of the first division. The number of the bivalent chromosomes may be counted as twenty.

6. In the first division the chromosomes are divided along the conjugated planes; thus the first division is a reducing one. In the second all the chromosomes become so placed that their longitudinal splittings coincide with the equatorial plane, and along this line all the chromosomes as well as the XY are divided at the same time; thus the second division is an equation division.

7. The XY-chromosomes exist and can be traced with certainty up to the primary spermatocyte.

8. The chromatoid body first appears at the early prophase. In the reduction division this body enters undivided into one of the daughter cells and disappears in the "Schwanzmanschette" at the formation of the spermatozoa.

9. The mitochondrial granules appear in the spermatocyte as well as in the spermatogonia, but they increase in number during the growth stage. In the spermatid they become arranged spirally around the axial filament.

10. In the spermatogonia and the spermatocyte the centrosomes could not be seen. Its behavior in the development of the spermatozoa is almost similar to the condition found by DUESBERG ('08) in the rat.

II. OBSERVATION IN THE RABBIT.

1. The resting nuclei of the spermatogonial cells usually contain many chromatin masses and several nucleoli.

2. The number of spermatogonial chromosomes is considerably varied.

3. The resting primary spermatocytes usually appear.

4. In the synaptic stage the chromatin spiremes aggregated at one nuclear pole where the idiozome is situated. In this stage the parallel arrangement of the chromatin spiremes is clearly to be seen.

5. In the prophase several ring-shaped chromosomes appear which are different in appearance from those of the mouse. In this stage the number of chromosomes may be counted as twenty four.

6. In the growth period two or more nucleoli can usually be seen, similar to those of the mouse in their behavior.

7. The first division is a reducing one and the second an equation.

8. The chromosome nucleolus or the accessory chromosome can be traced

throughout the growth stage and the reduction division. The behavior of this chromosome is entirely similar to that of the horse.

9. The behavior and form of the mitochondria are entirely similar to those of the mouse.

10. The chromatoid body appears in the early prophase. This body can be seen in the reduction division, but usually disappears in the secondary spermatocyte.

11. The behavior of the centrosome and of the idiozome in the formation of the spermatozoa, except in some points, is entirely similar to that of the guinea-pig, reported by MEVES ('99)

III. CONCLUSION.

1. From the results obtained by the measurement of the size of the spermatogonial chromosomes, it is found that pairs of chromosomes exist and that there is a constant relation between their size and their form. In the series of chromosomes arranged according to the size and form, two special chromosomes can be seen which are probably the sex-chromosomes.

2. The variation in the number of chromosomes in the rabbit is probably due to the fragmentation of certain chromosomes caused by the fixation of the materials.

3. The synisesis is the normal process which occurs in the definite period of the spermatocyte.

4. The conjugation of the chromosomes probably takes place by telosynapsis in the mouse and parasynapsis in the rabbit.

5. From the behavior of the sex-chromosomes it is conceivable that with regards to the existence of the sex-chromosomes, dimorphism must exist among the spermatozoa.

6. The nucleolus of the spermatocyte does not represent accumulations of by-products of the nuclear actions but consists of the ground substance (plastin ?) and the other achromatic substance which is probably to be used in the growth of the chromatin spiremes.

7. The change of staining capacity of the chromatin spiremes in the growth period is due to the accumulation of the achromatic substance in the chromatin epiremes.

8. The mitochondrial granules do not originate from the nucleus in the early stage of the spermatocyte, but exist in the cytoplasm from the beginning.

9. The chromatoid body is not an essential organ for the development of the spermatozoa and probably originates from the nucleus during the growth period of the spermatocyte.

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EXPLANATION OF PLATES.

All figures were drawn with aid of a camera-lucida, using a Zeiss 1.5 mm. apochromatic objective and compensating ocular no. 12, excep. figs. 130, 133 which were drawn with Zeiss 3 mm. apochromatic objective and compensating ocular no. 6 All the figures on Pl. IV, V, VI, VII, figures 82-84 on Pl. VIII, and figures 126-144 on Pl. X are from mouse. Those in Pl. IX, figures 85-102 on Pl. VIII and figs. 145-151 are from rabbit.

PLATE IV.

All the figures drawn from mouse.

Fig. 1. Spermatogonium in resting stage, showing chromatin masses and nucleolus,

Fig. 2. Spermatogonium in early prophase, showing many chromatin rods.

Fig. 3. Spermatogonium in late prophase.

Figs. 4, 5. Polar views of metaphase plates of spermatogonia, showing forty chromosomes.

Fig. 6. Polar views of metaphase of spermatogonium, showing mitochondrial granules.

Fig. 7. Side view of metaphase of spermatogonium.

Fig. 8. Side view of anaphase of spermatogonium.

Figs. 9–10. Chromosomes of spermatogonia arranged according to their area, showing pairs of chromosomes and two special chromosomes.

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Fig. 14. Side view of late anaphase of spermatogonium.

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Figs. 16, 17. Spermatocytes in synaptic stage, showing mitochondrial granules.

Fig. 18. Spermatocyte in late synaptic stage.

Figs. 19, 20. Spermatocytes in postsynaptic stage, showing nucleoli.

PLATE V.

All figures are from mouse.

Fig, 21. Spermatocyte in post-synaptic stage, showing chromatoid body.

Figs. 23–25. Spermatoeytes in late post-synaptic stage, showing nucleoli, chromosome nucleoli and chromatoid bodies.

Fig. 26. Spermatocyte in late post-synaptic stage, showing mitochondrial granules.

Fig. 27. Spermatocyte in late post-synaptic stage, showing change of staining capacity of chromatin spiremes.

Figs. 28–33. Spermatoeytes in prophase of first division, showing various ring-shaped chromosomes.

Figs. 34–38. Polar views of early metaphase of first division, showing formation of tetrads.

PLATE VI.

All figures are from mouse.

Figs. 39–41. Polar views of metaphase of first division.

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All figures are from mouse.

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Figs. 82–84 are from mouse, Figs. 85–102, from rabbit.

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Pig. 96. Spermatocyte in leptotène stage.

Fig. 97. Synaptic stage.

Fig. 98. Synaptic stage, showing mitochondrial granules.

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Fig. 100. Post-synaptic stage.

Figs. 101, 102. Spermatocytes in diplotène stage.

PLATE IX.

All figures are from rabbit.

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PLATE X.

Figures 126–144 are from mouse; Figs. 145–151, from rabbit.

All figures were drawn from preparations stained with AUERBACH's method.

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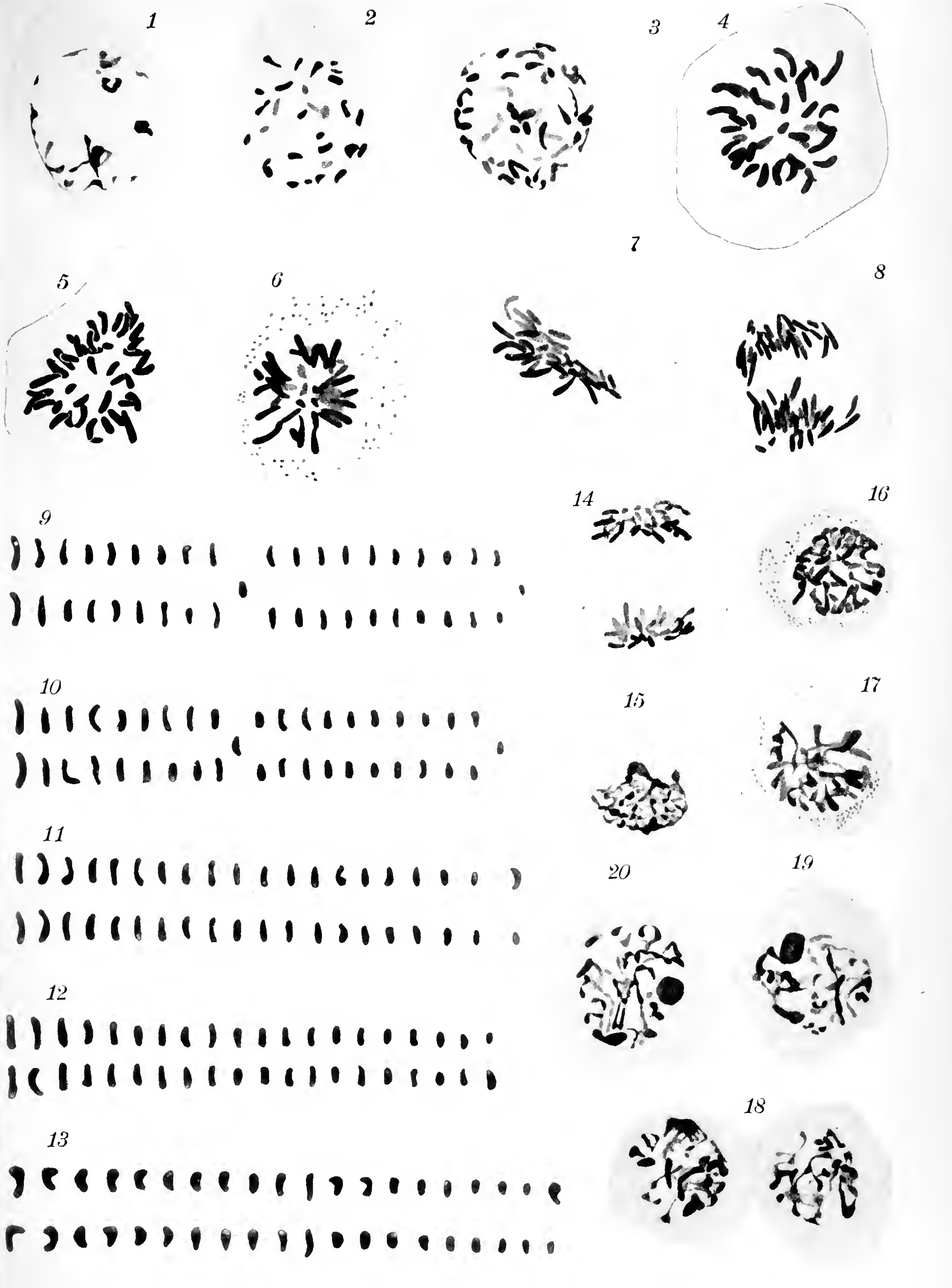

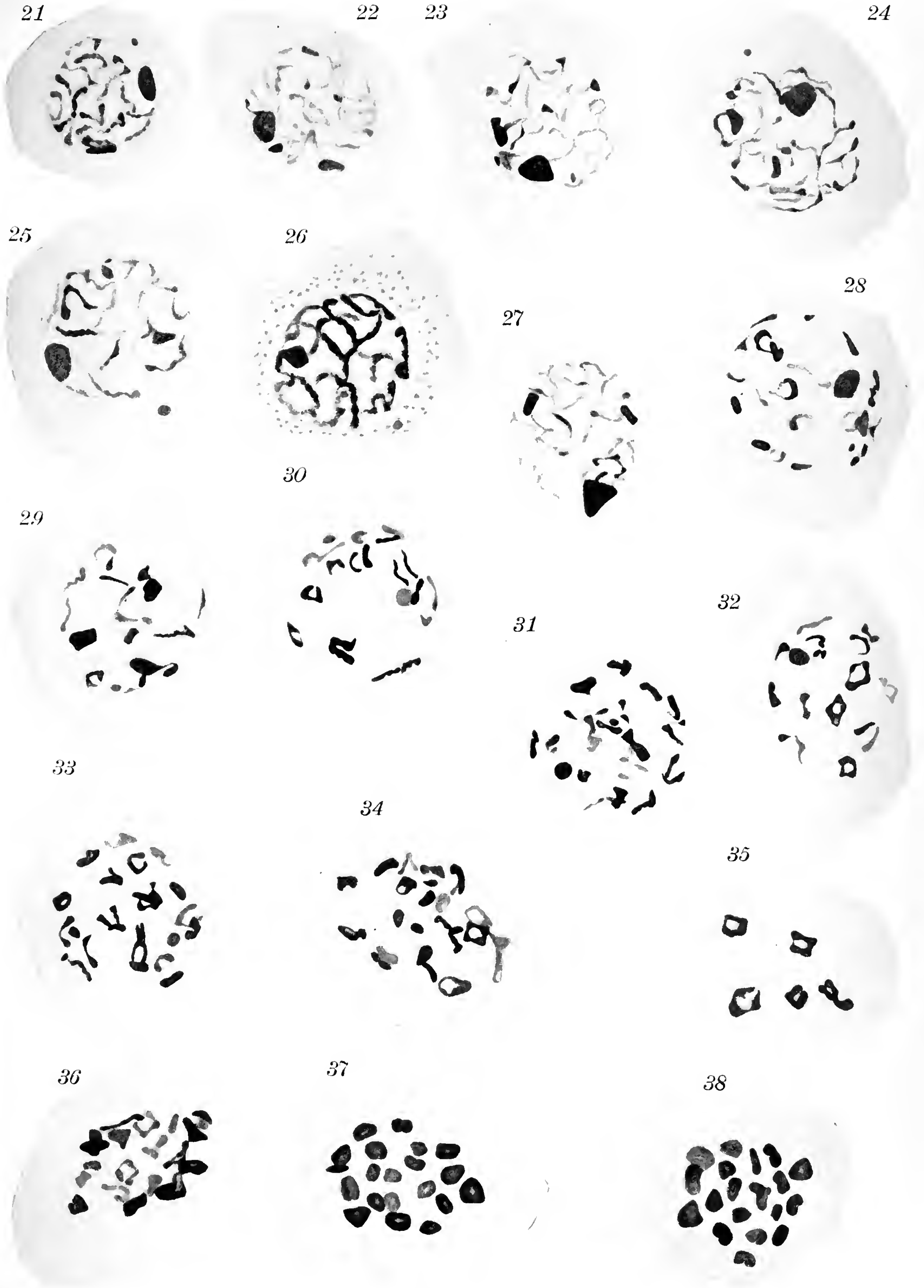
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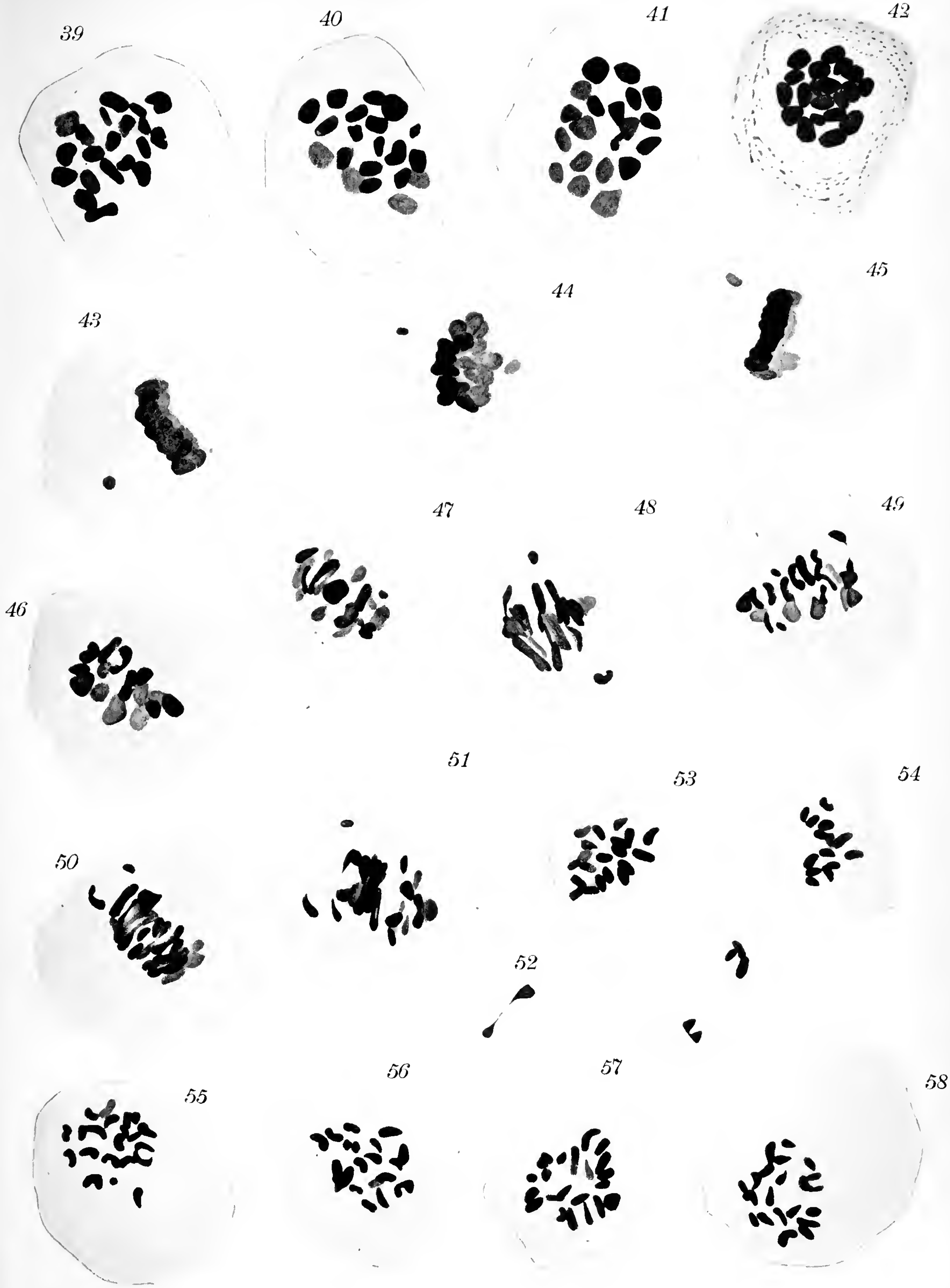
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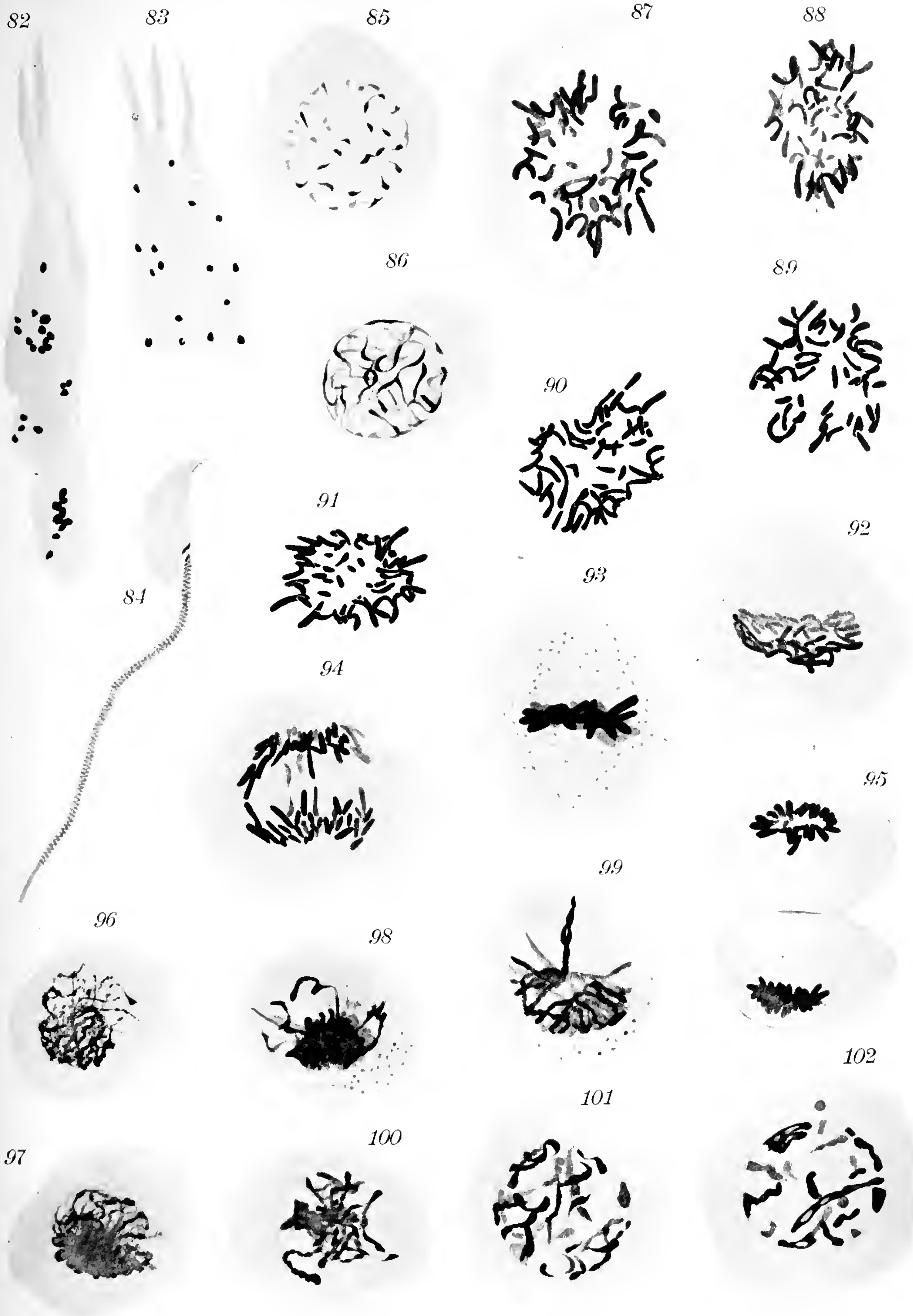
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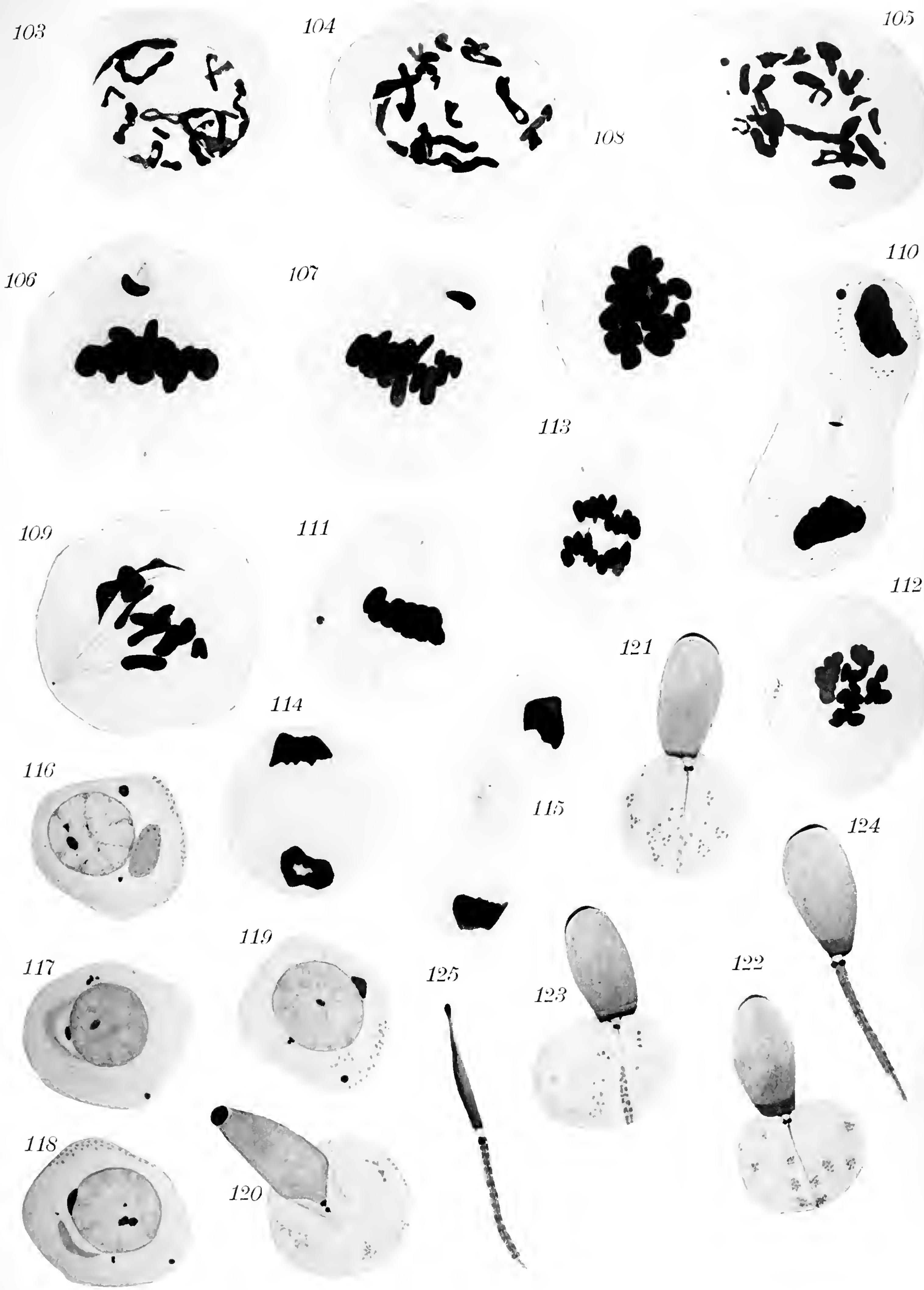
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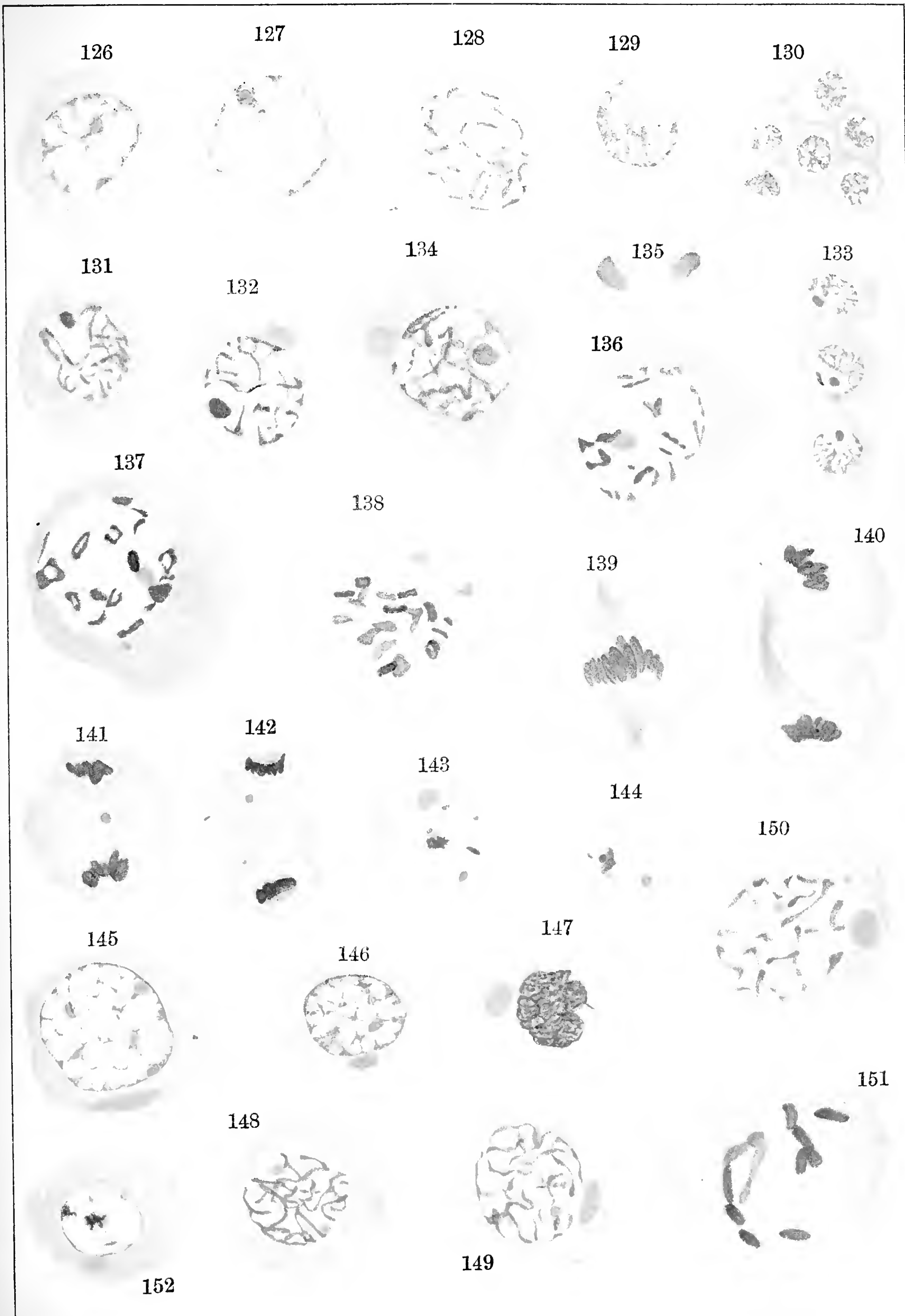
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Studies in the Effect of Röntgen Rays upon the Development of Vicia faba[1].

By

Hideo Komuro.

With Plates XI-XII and one Text-figure.

CONTENTS.

1. Introduction.
2. Historical survey of the effect of Röntgen rays upon the higher plants.
3. Culture experiments.
4. Germination experiments.
5. Discussion.

I. Introduction.

From the experiments carried out during a period extending from March 1917 to April 1922 with interruption of some months the writer obtained the following new facts besides several other results. Strongly irradiated seeds in air-dried and steeped condition do not stop their development immediately, they germinate and develop for a certain period. Sprouts from irradiated steeped seeds containing much water do not appear above the soil and their development ceases at almost the same stage of growth under the ground irrespective of doses given. When the dose of Röntgen rays exceeds a certain limit, no difference is seen in the state of impediment proportional to the dose and their effect is no more than an injurious stimulation to the seeds.

From the above results the writer presumes that strongly irradiated seeds

1. The present work was carried out by a grant from the MORIMURA Hômei Kwai. The main part of this paper was read before two meetings of the "Tôkyô Igakkwai" (Tôkyô Medical Society) on Nov. 5, 1917, and on Oct. 6, 1919, incorporating the results of germination-experiments which were made during June, 1919, and published in Japanese in the "Irigaku Ryôhô Zasshi" (1918), the Tôkyô Botanical Magazine (1919 and 1920) and in the "Keiô Igaku" (1921).

He recognized the practicability of X-rays, based on this positive stimulus by weak irradiation, and found an acceleration of growth.

WETTERER (1913) divided seeds of *Helianthus annuus*, which had been steeped in water for 3 days, into five parts, one of which was taken as the control and the rest exposed to the rays of 5 H, 10 H, 20 H, and 40 H. Then they were sown in a rich soil. The control, 5 H- and 10 H-plants sprouted almost at the same time, the 20 H-plants came out later and crooked. Of the 40 H-seeds none germinated.[1] Compared with the control, the 5 H-, 10 H- and 20 H-plants showed an inferior growth proportional to the increase of the dose. He cropped the seeds from the 20 H-plants as well as the control anp sowed them in soil in the beginning of the next summer (Frühsommer). From the control seeds, stout plants developed, but from the 20 H-seeds shorter and worse developed plants than the control were obtained, yet they were better than the mother plants, from which the seeds were derived. The second generation of the irradiated plants, which were impeded in their earlier development was worse in growth, but the impediment was less than in the first generation. The seeds cropped from these plants were sown out next year, the resulting plants had the normal form and height, and there was no change. Thus, he concluded that the effects of Röntgen rays do not appear in the third generation. According to the results of his experiments, the state of impediment in the same irradiated material is proportional to the doses given.

ERWIN SCHWARZ (1913) made experiments in order to find: 'wo lag das Optimum jener Strahlenmenge, die wir für die Reizwirkung brauchten?' and 'in welchem Stadium der Entwicklung der Reiz einsetzen mußte, wenn er in günstiger Weise zur Geltung kommen sollte', and he said "daß es mir nur dann gelang, eine Wachstumsbeschleunigung zu erzielen, wenn ich Samen vor der Auskeimung oder ganz junge, eben ausgekeimte Triebe bestrahlte, während es sich trotz aller möglichen Versuchsanordnungen als unmöglich erwies, ältere, bereits heranwachsende Pflanzen zu beschleunigtem Wachstum anzuregen". The writer gives here the results of his experiments. He irradiated dried seeds of *Vicia faba* as in the following table, and compared the length

1. The writer presumes that by "nicht aufgehen" the author means that the plumule did not come out on the surface of the soil.

of shoot as to the difference of influence caused by the irradiation. (The irradiated seeds were sown in a soil, 3 grains to a pot, all placed near the window.)

No. of pot	Time of exposure	Length of shoot (cm.) (after 3 weeks)
I	Control.	24.5
II	30 sec.	20.0
III	90 „	44.0
IV	1 min.	41.0
V	2.5 „	51.0
VI	5 „	2.0–3.0

As the table shows, the plants grown from the seeds irradiated for 2.5 minutes were best in growth—2.5 minutes' exposure is equal to $\frac{1}{24}$ H, because scarcely $\frac{1}{2}$H was given by continuous irradiation of 30 minutes—so he considered that $\frac{1}{24}$ H was the minimum dose for the growth to be affected positively. Next he avoided chance weak irradiation of vigorous seedlings, they develop better as a natural consequence. He wished to make researches on the effect of X-rays upon germinated seeds, so he chose the seedlings of *Vicia faba* which had previously been germinated in a thermostat, and irradiated them to such a degree that the most vigorous one was the weakest and the weakest or the one without sprout was the strongest. Then they were planted out at the same depth.

No. of pot	State of seedlings	Time of exposure (seconds)	Length of shoot 3 weeks after, in cm.
I	strongest, long sprout	Control	25.0
II	somewhat weaker sprout	30	40 0
III	still weaker sprout	60	42.5
IV	very weak sprout	120	43.5
V	very small or without sprout	240	37.0

After 6 days the sprouts of seedlings Nos. III and IV appeared above the surface of the soil, the latter of the two was better in growth and one of the shoots reached 1 cm. The length of shoot is tabulated above. So he said: "es werden demnach die Bohnen, die sich gegenüber den anderen durch eine gewisse Keimträgheit kennzeichnen, durch die Bestrahlung derart angeregt, daß sie

die sich normal entwickelnden weit überholen". 'How long does the stimulation continue after irradiation?' was tested on the dried seeds of *Vicia faba*. The seeds were exposed to the rays for 60 and 200 seconds, immediately separated and put in envelopes. Then they were sown 4 and 8 weeks after irradiation. From the results of these experiments he concluded that, "der durch die Röntgenbestrahlung gesetzte Wachstumsreiz scheint demnach für eine bestimmte Zeit im Keime zu ruhen und dann noch in ziemlich unveränderter Kraft zur Geltung zu kommen, wenn dieser nach Wochen ausgesät wird. Mit zunehmender Dauer des Latenzstadiums geht jedoch die Reizwirkung mehr und mehr verloren. Diese Ergebnisse ähneln in gewisser Hinsicht den von WETTERER mitgeteilten, wenn dieser die durch intensive Bestrahlung erzeugte Wachstumshemmung noch bis in die 2. Generation verfolgen konnte".

KOERNICKE (1915) who had experimented in 1904 on the effect of the rays upon *Brassica napus*, *Vicia faba* and *Vicia sativa*, now used the following plants: *Vicia faba*, *Phaseolus multiflorus*, *P. vulgaris*, *Lupinus albus*, *Brassica napus*, *Sinapis arvensis*, *Papaver somniferum*, *Zea mays*, *Triticum vulgare* and *Avena sativa*. He experimented to find out if the Röntgen-culture is possible. The results of his researches are closely connected with those of mine, and, therefore, the writer proposes to give a rather detailed abstract. KOERNICKE repeated the conclusion of his former experiments: "Röntgen- und ähnlich auch die Radiumstrahlen wirken in genügend starker Intensität hemmend auf das Wachstum ein. Nach der Bestrahlung ist zunächst nichts von einer derartigen Hemmung zu bemerken, ja es tritt zunächt meist eine Wachstumsbeschleunigung zutage. Die Hemmung folgt vielmehr erst einige Zeit nach der Bestrahlung. Der Zeitpunkt des Eintretens dieser eigenartigen Nachwirkung ist von dem Objekt und seinem physiologischen Zustand im Moment der Bestrahlung abhängig. Ist die Intensität der Bestrahlung nicht stark genug gewesen, so bleibt die Wachstumshemmung nur eine vorübergehende", and he stated anew that, "die verschiedenen Pflanzenarten zeigten oft starke Unterschiede in ihrer Sensibilität den Strahlen gegenüber. Jedenfalls sind manche Abweichungen in den Versuchsresultaten auf die geringe Kontrollmöglichkeit der jeweils zur Wirkung gebrachten Strahlungsintensitäten zurückzuführen". The methods of his experiments were: the

material used for irradiation was (1) air-dried seeds ("trockene, ruhende Samen"), (2), one day, two days and a few days' water-steeped seeds, (3) those with radicles, and (4) seedlings which previously had been germinated in the pot and were in the same state of growth, and their development was observed. The doses given were in the first experiment of ten kinds, *i. e.*, 5 H, 3.5 H, 2.5 H, 1.5 H, $\frac{1}{2}$ H, $\frac{1}{10}$ H, $\frac{1}{20}$ H, $\frac{1}{40}$ H, $\frac{1}{60}$ H, and $\frac{1}{100}$ H. In the other case, strong irradiation was employed. 220–3,000 grains of seeds were used in every experiment, sown into a pot containing wet poplar saw-dust after the irradiation and planted in open ground after their first development. He said that, "von den Versuchspflanzen wies eine sichtliche Beeinflussung des Wachstums durch die Röntgenstrahlen eigentlich nur *Vicia faba* auf. Betreffs der Keimung zeigten allerdings die übrigen Versuchspflanzen, außer den Getreidearten, bei welchen überhaupt keine Wirkung zu erkennen war, analoge Verhältnisse wie *Vicia faba*, wenn auch in schwächerem Maße". The results of experiments were, (1) in the case of air-dried seeds: the strongly irradiated germinated generally sooner than the weakly or unirradiated. At first there was a difference in growth, but they were balanced in the flowering time, (2) in the case of steeped seeds; the one or two days steeped gave the same results as those under (1), in three days steeped seeds, the growth of 3.5 H- and 5 H-plants was impeded a little at first—there was a difference proportional to the doses given—but afterwards it was balanced, (3) in the case of the seeds with radicles, the growth of 1.5 H was at first inferior. But the growth of $\frac{1}{65}$ H – $\frac{1}{20}$ H seedlings was accelerated. A part of these materials showed marked differences at first, but afterwards they were perfectly balanced and in the flowering time these plants showed a similar state of development to the 5 H-plants which were somewhat slender. Then he said, supporting E. Schwarz's statement, that "an den bereits im vorgerückten Keimungszustand bestrahlten Pflanzen war von einer Förderung des Wachstums, auch nach Applizierung der schwächeren Dosen, nichts zu bemerken. Bei den Dosen von 3X (=1.5 H) an aufwärts fiel dagegen besonders stark der schädigende Einfluß auf: die Pflänzchen blieben bald entsprechend der Intensität der erhaltenen Dosis in ihrer Entwicklung zurück". When four weeks had passed after the irradiation, the 5 H-plants did not make any further growth. The 1.5 H-, 2.5 H- and 3.5 H-plants ceased to grow proportional to the doses given.

He formulated G. SCHWARZ's conclusion in other words, surveying the results of his experiments: "die verschiedenen Pflanzenarten besitzen eine verschiedene Röntgenempfindlichkeit; je reger die Lebenserscheinungen in einem Organismus von statten gehen, desto stärker und eher macht sich der Einfluß der Bestrahlung geltend". He recognized an acceleration of growth only when air-dried and germinated seeds had been irradiated, but the growth could not be accelerated at all by the strong irradiation which E, SCHWARZ gave. E. SCHWARZ exposed air-dried seeds to the rays of $\frac{1}{12}$ H and observed a marked impediment of growth, but in KOERNICKE's experiments this small dose caused no effect upon them, and an impediment of growth appeared first at above 50 H. He stated on the impossibility of Röntgen-culture: "mit der Feststellung der Tatsache, daß die meisten der zu den Versuchen herangezogenen Samen von Kulturpflanzen so wenig röntgenempfindlich sind, dazu bei der am meisten röntgenempfindlichen dicken Bohne die Sensibilität je nach der Sorte und bis zu einem gewissen Grade auch bei jedem Individuum innerhalb der Sorte schwanken kann, ist die Aussicht auf eine praktische Verwendbarkeit der Röntgenstrahlen in der Landwirtschaft, wie sie sich in Anknüpfung an die SCHWARZschen Untersuchungsresultate zunächst zu eröffnen schien, geschwunden". The interpretation of his experiments was that the size of experimental objects and the number and size of their single cells is in relation to their sensibility to X-rays, and stated thus: "bei der dicken Bohne (*Vicia faba*) zeigte sich eine Schädigung bei Intensitäten über 100 X (=50 H); bei dem Mais (*Zea Mays*), dessen Körner beträchtlich geringeren Umfang besitzen, erst bei 250 X (=125 H); die winzigen Mohnsamen (*Papaver somniferum*) schließlich keimten noch bei Dosierungen von 500 X (=250 H) fast ungeschwächt". He concluded that "in ihrer Wirkung auf den pflanzlichen Organismus lassen sich die Röntgenstrahlen mit anderen Strahlungen in Parallele stellen, die in stärkerer Intensitat einen wachstumshemmenden Einfluß ausüben, ja direkt schädigen, in schwächerer jedoch wachstumsanregend, bezw. -beschleunigend wirken können und so sich ähnlich verhalten wie andere in stärkerer Applizierung dem Pflanzenleben schädliche Agentien, z. B. Verletzung, vor allem Gifte, deren wachstumsstimulierende Wirkung bei schwächeren Dosen gerade jetzt wieder Untersuchung erfährt".

CASIMIR exposed the seedlings of *Vicia faba* to the rays of 200 H and investigated cytologically. According to the description of J. WETTERER,[1] CASMIR's result was as follows:—"Als Resultat der Bestrahlung ergab sich, daß in dem Keimling die Zell- und Kernteilung völlig zum Stillstand gelangt war. Am deutlichsten traten Zerfallserscheinungen am Zellkern auf, bestehend in Karyorhexis und Karyolysis. Die enorme Dosis hatte so prompt auf die lebhaft proliferierenden Zellen der Keimlinge gewirkt, daß der Kernteilungsprozess sofort inhibiert war".

The writer (1916) made a cytological investigation on *Vicia faba* exposed to the rays of 5 H, 10 H, 20 H, 40 H, 60 H and 80 H. The results obtained were as follows: in the preparations of 5H–20H, there appeared no difference compared with the control, in the 40 H preparations, more mitotic figures were found than in the case of others, and the chromosomes seemed to become somewhat thick and short compared with the control, but there was no change in the division figures, and the stage of anaphase and telophase were found frequently in each preparation, and in the preparations of 80 H the nuclei were more or less degenerated, the outline of the nuclear membrane being scarcely visible. In such cells, the cytoplasm was filled with large vacuoles. The starch grains in the root cap (and the lower part of the periblem) were found to have changed in size and were more scattered in the cell. The writer observed that the chromosomes assumed an irregular arrangement and became more or less slender in the metaphase, and the stage of anaphase and telophase were very rare and were found in an abnormal state.

YAMADA (1917) reported the results of the culture-experiment on *Oryza sativa* exposed to the rays. He used "Takenari", an aquatic race of *Oryza sativa*, for his experiments and irradiated them as follows:—

No.	Dose	Time of exposure (minutes)
I	3 H	10
II	5 H	16
III	7 H	22
IV	10 H	30

1. WETTERER, J. Handbuch der Röntgentherapie, 1. Bd. pp. 299–300.

Before the irradiation, he steeped the grains in salt water to select them, and then steeped them in water for 168 hours (7 days). He placed them flat in a porcelain dish after leaving them 4 hours out of the water, and irradiated with the above doses. Then they were again steeped in water 2 hours after irradiation and sowed in a paddy soil, one grain for one stock, 48 hours after irradiation. His results were: an acceleration of germination was not observed, the growth of the irradiated plants was at first inferior to the controls, but later the growth of 3 H-plants became the best, and the number of tillers was larger than in the others. The 7 H- and 10 H-plants were damaged by insects and fungous disease, and the crop was decreased by these obstructions. The 3 H-plants showed 40% increase in the amount of crop. According to the results of the cropping of a limited area (one "tsubo"), the 3 H- and 5 H-plants showed 8.3% and 2.9% increase of crop, and the 7 H- and 10 H-plants 2.4% and 5.4% decrease of crop (this might be caused partly because of the damage by insects and disease), *i. e.*, the 3 H- and 5 H-plants gave better results than the controls.

NAKAMURA (1918) published the results of culture-experiments of *Oryza sativa* ("Sinriki"), of which grains were exposed to X-rays for 5, 10 and 15 minutes after steeping in salt water and then cultivated in a paddy soil. He reported that the plants grown from seeds with 5 minutes' exposure showed an increase in the amount of crop.

The writer's results (1919) of germination-experiments with *Oryza sativa* ("Sekiyama")[1] showed an acceleration of germination, and that of seeds irradiated in air-dried condition was more manifest than that of irradiated seeds after 12 hours steeping. For air-dried grains with a water content of ca. 8%, 5 H-10 H was the optimum dose for acceleration.

From the writer's experiments (1922) of cultivation of air-dried and steeped irradiated plants of *Oryza sativa* ("Sekiyama") in WAGNER's pots and on a paddy soil in 1919 and 1920, it will be seen that the amount of crop in *Oryza sativa* is not at all increased by the irradiation of X-rays. The only change produced by irradiation was precocious growth; young plants reached the stage at which they can be transplanted earlier than the control.

The writer (1922) made a cytological investigation on the root-tips of

1. "Sekiyama" is one of the pure lines of an aquatic race of *Oryza sativa*.

Vicia faba, "Hyôgo", grown from irradiated seeds. The cells of the radicle of the 50H irradiated seeds showed changes, such as formation of multinucleated cells, enlargement of both the cell and the nucleus, vacuolization of both the nucleolus and the cytoplasm, increase of the number of nucleoli and decrease of chromatic substance. Mitoses are very seldom met with and almost all cases were anomalous, the chromosomes having become fragmentary and scattered in the cytoplasm, and mechanical tissues developed, while in the controls he could find numerous mitotic figures, no differentiation of mechanical tissues having taken place. In the periblem tissue many cells are found in karyolytic condition and others in pyknosis. Even in the tissue adjacent to the growing point pyknotic cells are found. It is interesting to find, that these changes resemble those of tumor cells (especially in the testis-carcinom of the horse). It may safely be said that irradiation of X-rays (large dose) upon the seeds of *Vicia faba* leads the cells of radicles to a diseased or senescent condition resembling that of tumor cells.

The results of the above mentioned authors can be summed up as follows:—

1. Röntgen rays have a harmful effect on the seeds proportional to the water contents of seeds.

2. The seeds, which are late in germinating, as *Vicia faba*, were stimulated by Röntgen rays. The germination of *Calystegia hederacea*, *Oenanthe stolonifera* and *Oryza sativa* was accelarated.

3. To irradiate the seeds with a moderate dose before sowing gave good results for the growth of the plants *i. e.*, it became a positive stimulus.

4. The irradiation of younger plants does not produce any acceleration of growth and affects them rather harmfully proportional to the degree of dose.

5. The plants have different sensibility to Röntgen rays, *i. e.*, they show "selective absorption".

6. In weak irradiation, the harmfulness of the rays is proportional to their intensity.

7. Even if we expose seeds containing much water to a high dose of Röntgen rays, we cannot make the seeds stop their development immediately. They germinate and develop for a certain time.

8. According to the cytological observation of the tip of radicles from

the irradiated seeds of *Vicia faba*, there was no difference in the condition of cells compared with the control in weak irradiation; with a certain dose, there were rather many division figures, but after strong irradiation mitoses are very seldom met with and almost all cases were anomalous, the chromosomes having became slender or fragmentary and were scattered in the cytoplasm, and, moreover, the mitotic figure of anaphase and telophase was very rare and occasionally irregular. After a certain dose, the chromosomes became short and thick, the nuclear membrane somewhat irregular, and the chromatic substance increased or decreased very much. In other cases, changes were seen, such as multi-nucleated cells and others, resembling those of tumor cells.

9. From the cytological observation of young plants of *Vicia faba* irradiated with 200 H, the cell and nuclear division were entirely interrupted and the periphery of nuclei destroyed, some in karyolytic condition and others in karyorrhexis.

III. Culture Experiments.

It was the wish of the writer to show by Experiments I–IV that an impediment of growth will occur with any of the doses given. E. SCHWARZ (1913) observed the apparent impediment by $\frac{1}{12}$ H on the seeds in a resting state (air-dried seeds) of *Vicia faba*. M. KOERNICKE (1915) denied this and said that in air-dried seeds of *Vicia faba* the impediment appeared first at above 50 H, moreover, he reported that seeds on which the tip of the radicle appeared after many days steeping were severely impeded in their growth by 10 X(=5 H) and 15 X(=7.5 H).

G. SCHWARZ (1907) studied the relation between the sensibility to Röntgen rays and the water content of seeds, and said that the sensibility to Röntgen rays is proportional to the degree of the water content of irradiated cells, so the writer steeped the seeds in water for different lengths of time and determined their water content.

The seeds used for these experiments were "Sengoku-kurome", a race of *Vicia faba* obtained from the Tôkyô Kônôen, the air-dried weight of which was 0.9 gr.

It was the great regret of the writer that he could not use more than 20 seeds for each dose, because the Röntgen tube used permitted only ca. $\pi 10^2$ cm.

area for effective exposure, and this area will only admit about 130 seeds swelled as the result of steeping.

Notice:—The following abbreviations are used in this paper for convenience: "Tube distance" means the distance between the Röntgen-ray tube-focus and the object to be irradiated, "Irradiated material" means the seeds and plants irradiated.

Irradiation[1] was made by KÔITI FUJINAMI at the Röntgen Laboratory of the Juntendô Hospital in Tôkyô. Tube distance was 15–30 cm. The Röntgen tube used was GIBA's water-cool tube with a hardness of BENOIST 6°, and the current passing through it was 10 milliampères. To irradiate the seeds, they were placed flat in a porcelain dish (cuvette), and care was taken to irradiate uniformly in turning the seeds over and over again and changing their position as the tube was changed.

EXPERIMENT I.

The seeds were steeped in water for 46 hours prior to the experiments and exposed to the rays of 40 H, 50 H, 60 H, 80 H, 100 H, 120 H, 150 H when the water content reached 57.49%, on March 17, 1917. 21 hours after irradiation they were sown on March 18 in the field, one grain for one stock, the distance between the rows of field was 2 *syaku*[2] and the distance between the plants was 1 *syaku*. The writer was permitted to use Marquis YOSITIKA TOKUGAWA's field at Fujimi-Chô, Azabu, Tôkyô, for which favour he expresses his hearty thanks. The field consisted of clay soil, and the former crops were *Brassica campestris* L. var. (mikawasima-na), *Solanum melongena* L. in 1915 and *Arachis hypogæa* L. in 1914.

The manure given was 5 gr. of calcium superphosphate and ca. 140 gr. of stable manure to each stock.

The experiment extended from March 19 to May 10, 1917.

Ten seeds of each group were sown with the same number of unirradiated controls, surrounded by two extra rows in the same distance of rows and plants. This care was taken to minimize the special effect of surroundings.

The results of this experiment are tablated below.

1. The writer expresses his hearty thanks to Mr. MATSUDAIRA for his kindly help in the irradiation.

2. *syaku* = 0.30 m.

TABLE I.

Dose	State of underground (May 10)	
	No. of seedlings	No. of dead seedlings
40 H	2	
50 H	1	1
60 H	1	1
80 H	5	
100 H	1	1
120 H	1	1
150 H	3	2

Control:—Of 10 seeds 8 developed into plants about 20 cm. in length.

As Fig. 1 shows, the irradiated seeds, whose sprout did not appear on the surface of the soil, germinated, and, moreover, they were of almost the same size and most of them were dead, but of the rather strongly irradiated ones many remained. The middle of 150 H-seedlings in Fig. 1 remained healthy up to the end of the experiment (May 10). It is proved by the aftermentioned culture and germination experiments that seeds containing more than 50% water, when the dose of X-rays exceeds a certain limit, will be affected only to an injurious stimulation. That many strongly irradiated seeds remain, may be due to the fact, according to the writer's supposition, that the strongly irradiated take a much longer time to develop to a state where the growth ceases, the weakly irradiated may reach this state sooner than the former.

EXPERIMENT II.

In the second experiment, the writer modified the mode of cultivation and used a different kind of soil. Special wooden frames were made instead of large pots, which were 6 *syaku* long, 1 *syaku* wide and 1 *syaku* high.

5 of these frames were placed on the ground and the same quantity of humus was filled in each. Seven irradiated seeds which came from the same batch used for the first experiment were used. They were sown with controls on a straight line in the middle of the frame, with intervals of 5 *sun*[1] and two

1. *sun* = 3.03 cm.

extra seeds were sown on both sides, in the same intervals. Besides, two sets of 7 *sun* pots were prepared for the rest and seeds sown in respectively. When this was done, 17 hours had elapsed from the end of the irradiation.

One can keep environmental conditions fairly constant when sowing the seeds in a limited place, and thus the frame was constructed instead of the pots.

Manure given was the same as in Experiment I. The experiment extended from March 10 to May 22, and during this period rainy days were rare, so the frame and pot were watered every day.

The results of this experiment are tabulated below.

TABLE II.

Dose.	No. of seeds.	State on May 4 (48 days after sowing)		State on May 22. (66 days after sowing)		
		No. of sprouted seedings	Length of shoot	No. of dead seedlings	No. of plants	No. of rotted seeds
40 H	7	3	Vis.– 11.0	1	1	1
50 H	,,	4	,, – 1.5	1		4
60 H	,,	1	0.5	2		1
80 H	,,	3	,,	3		2
100 H	,,	1	Vis.	2		1
120 H	,,	3	Vis. – 0.9 – 1.3	3		2
150 H	,,	2	Vis. – 1.2	4		1
Control.	,,	7	11.0		7	

In the table, the writer used "vis." (visible) to indicate the length of shoot. It means a very small sprout which scarcely came above the surface of the soil. In this experiment, the irradiated material sprouted on the soil, while none sprouted in Experiment I, so the writer tabulates the length of shoot to indicate the degree of sprouting, he wished by no means to compare by this length the difference of growth proportional to the doses given. One of the 40H-plants developed as well as the unirradiated control plants and showed a length of shoot of 36.5 cm. at the end of the experiment.

As is clearly shown in Fig. 2, the plants ceased to grow at almost the same state as in Experiment I, this may be explained by the above stated

assumption of the writer, that of strongly irradiated seeds more remained, except one of the 40 H-plants.

The seeds used in Experiments I and II were irradiated at the same time and separated into two parts, one was used for field culture and the other for pot culture. Of these seeds, whose water content reached 57.49% by 46 hours' steeping, the majority of the 40 H showed the tip of the radicle to appear out of the seed coat; they also swelled very much compared with the others.

Experiment III.

The seeds were steeped in water for 31 hours (when the water content reached 50.08%) and exposed to the rays of 20 H, 30 H, 50 H, 60 H, 80 H, 100 H, 120 H and 155 H on March 31, 1917. Of 20 seeds of each group 18 seeds were used for this experiment and the rest for Experiment IV. The field used was one of the College of Agriculture, Imperial University, Tôkyô, The soil of the field consisted of humus, and the former crop was *Arachis hypogaea* L. The irradiated seeds were sown with the controls and extra seeds, as in the former case, and 3 gr. of calcium superphosphate and ca. 100 gr. of stable manure were previously given. The experiment extended from April 1 to June 16 in 1917.

The results of this experiment are tabulated in Table III, and shown in Textfig. 1 and Figs. 3 – 5.

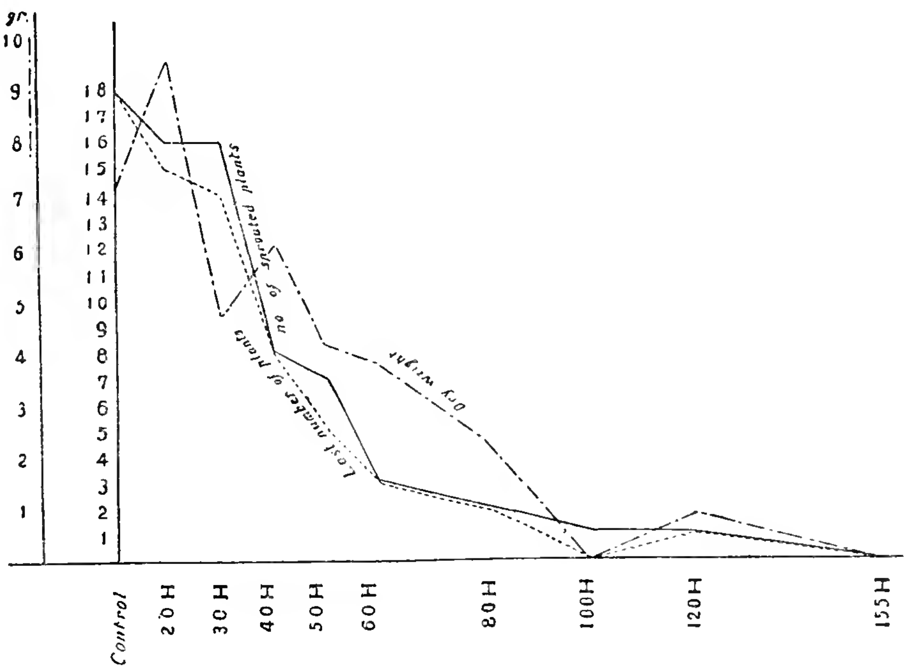
As the table and figures show, the 20 H-plants developed better in the field than the controls and other irradiated plants, and the 40 H-plants ranked next to the 20 H. 16 of 18 seeds of the 20 H and 30 H germinated and grew, and the other irradiated seeds decreased in the number of germinations proportional to the increase of the dose. None of the 155 H sprouted, but they germinated under the ground and developed to the state shown in Fig. 6.

The dry weight of the plants, whose growth in the field was better, was heavier than that of the others, as Table 3 shows (refer to the curve).

The experimental plants were attacked by *Pipistrillus abramus* since the middle of May, and there were plants which became impeded in growth and died, and, moreover, they were so severely injured that the flowers died before bearing fruits. This damage may have been caused by the unsuitable time

TABLE III.

Dose	No. of sprouted plants	State at the end of the experiment (June 16)	
		No. of plants	Average weight (gr.)
Control.	18	18	7.055
20 H	16	15	9.647
30 H	16	14	4.707
40 H	8	8	6.133
50 H	7	5	4.160
60 H	3	3	3.779
80 H	2	2	2.295
100 H	1	—	—
120 H	1	1	0.850



of cultivation, because *Vicia faba* must be sown in the middle or the end of October, but in this experiment it was sown on April 1, so the time was not fit for natural growth. But the writer supposed that it might be caused, on the one hand, by soil-sickness (Boden-Müdigkeit), due to the continuous cultivation of leguminous plants (for the former crop was pea-nut).

Conditions were as above mentioned, so the writer gave up the experiment

on June 16. Had he left the plants in the field, they would have been killed by *Pipistrillus*, and an observation of the results would anyhow have become impossible. He rooted up the plants, collected the fallen leaves of each plant, and determined the dry weight of each group (dessicated by a water-bath and dessicator), and intended to compare the differences of effect.

One or two exceptionally stout seeds, whose irradiation was above 80 H, developed to a plant, but the majority did not sprout at all, and no 155 H-plants came out on the surface of the soil. The dose above 50 H seemed to cause an injurious stimulation for the seeds whose water content was 50%. The 100 H-plant died before the last observation.

Experiment IV.

This was the water culture by Knop's solution, but only two seeds for each group were used for trial, because of want of equipments. The principal object of this experiment was to observe to what degree the plants will develop, whose sprouts do not appear above the surface of the soil.

Two seeds of control, 20 H, 30 H, 40 H, 50 H, 60 H, 80 H, 100 H, 120 H 155 H were sown in a large pot containing saw-dust on April 2, 1917. The seedlings of each group were brought into Knop's solution on April 9. Fig. 6 is the state on April 16, the 7th day after the treatment. 50 H-seedlings (for the wound) and seedlings above 80 H did not develop more than the state shown in Fig. 6. Fig. 7 is a photograph taken on May 1, and Fig. 8 on June 16 (at the end of the experiment). These plants were placed in the cold green house of our Institute. On May 29, the writer found the parasite of *Bacillus Fabae* Uyeda on the leaves of the 40 H-plant, so he pinched off 7 leaves. Afterwards, the plants of each group were attacked by *Pipistrillus abramus* and 0.3% solution of "Katakilla" was often coated on with a brush.

When the writer put the results of Experiments III and IV together, he came to the conclusion that except the exceptionally stout individuals irradiated material seems to have been impeded in growth generally at 60 H up, and these plants ceased to grow after a certain time. That is, these unsprouted ones germinated and developed equally for a certain period underground, and even the seeds exposed to the rays of 155 H did not cease their development at once but developed to a certain period as shown in Fig. 6.

In the seeds, whose water content was 50% (31 hours' steeping), there were creases on the seed coat, of course before the irradiation, at the time of sowing, 17 hours after the end of the irradiation, and the writer saw no conspicuous changes in 40H-seeds, as in the case of the seeds whose water content was 57.5% (46 hours steeping)—refer to P. 270.

Anatomical Observation of the Leaf.

Using the leaves of plants of Experiment III, the anatomical differences of the mesophyll of each group were observed, but there was no difference among these. But the attention of the writer was attracted by the fact that the quantity of chlorophyll of the 80 H- and 120 H-plants was less than that of the others, so that the appearance of those plants on the whole was yellowish compared with that of the control and the others. A 100 H-plant died before the observation.

The object of experiments from V to VII was to cultivate *Vicia faba* in the normal season and to compare with the results already stated which were obtained during the period extending from April to June under unsuitable environments for *Vicia faba*, and, on the other hand, the former experiments were repeated. Moreover, there was no experiment as to the effect of the rays upon the air-dried seeds in the former experiments, so the writer made it side by side.

Seeds of "Hyôgo" (1917-crop), a race of *Vicia faba*, were obtained from the farm of the College of Agriculture and used for these experiments. Unfortunately, the seeds were few in number, so the writer could not minimize the individual deviation of the weight of seeds, as in the former cases, but seeds with an air-dried weight of 0.97–1.07 gr. (average 1.02) were used for Experiments V and VI, and, in Experiment VII, seeds of 1.28 gr. (average) were used.

As to the irradiation, all the precautions were the same as in the former cases.

Method of Cultivation.

The field used was that of the College of Agriculture, composed of humus. The distance between the rows was 2 *syaku* and the distance between plants 5 *sun*. Two rows (front and rear) and three rows (right and left) of seeds were sown for extra.

Manure: ca. 100 gr. of stable manure and 1 gr. of calcium superphosphate were given on Oct. 26, after levelling the field and 1.5 gr. of wood ash on the day of sowing (Oct. 29). On April 2, 1918, diluted human manure mixed with rice bran was given.

Experiment V.

This was extended during the period from Oct. 28, 1917 to June 22, 1918.

The seeds were steeped in water for 24 hours, and, when their water content reached 57.32%, they were exposed to the rays of 20H, 40H, 60H, 80H and 100H[1]. Then they were sown[2] on Oct. 29 in humus, on which the previous crop was *Polygonum orientale* L., 20 hours after irradiation.

Care was taken to avoid the partial richness of soil in the field. The weather during the period extending from the end of October to the beginning of December was unsuitable for germination. The dates and the number of germinations are tabulated below :—

Table IV.

Day of sprouting \ Dose	Control	20 H	40 H	60 H	100 H
11/Nov.	10	1			
12	12				
13	13	6			
14	8	5			
15	7	3			
16	6	2			

1. It took 99 minutes to get 100 H.
2. Control seeds were 60, double the number of the irradiated.

Days of sprouting \ Dose	Control	20 H	40 H	60 H	100 H
18	1	4	1		
20		3			
22		2		1	
24		1			
27					1
4/Dec.	2				
10/″		1			
?	1				
Total.	60	28	1	1	1

As the table shows, it seems that the germination of irradiated seeds were not accelerated; it was, in fact, rather delayed. On Oct. 30, the writer took 1 or 3 seedlings carefully out of each group, which had not yet sprouted above the ground, and examined the state of growth under the ground. Though the tip of the radicle of strongly irradiated seeds appeared coloured brown and stumpy, as if somewhat injured, their cotyledon was vigorus. The control and 20 H-plants, on the contrary, were in the first stage of growth as young plants. According to this fact, strongly irradiated seeds may have been affected severely. The state of growth of 40 H up was almost the same and there was no difference in growth apparent proportional to the doses given.

On April 2, 1918, 56 control plants and 12 20H-plants remained and the ratio of the remainder at the flowering time (middle and end of April) is tabulated below:—

TABLE V.

Dose	Percentage of the sprouted	Percentage of the remainder to the sprouted
Control.	100.0	90.00
20 H	93.3	17.86
40 H	3.3	0
60 H	3.3	0
80 H	0	0
100 H	3.3	0

This Table is to be referred to Table VI.

TABLE VI.

Day of bloom \ Dose	Control	20 H
16/April	2	1
18	6	
19	8	1
20	6	
21	19	1
22		1
24	8	
25	3	1
Total	52	1

As Table VI shows, it is evident that the time of bloom of the 20 H-plants was not accelerated. The growth of 20 H was inferior to that of the controls. The damage by *Pipistrillus abramus* became manifest in the middle of May, the plants were severely stunted, but produced seeds (see Figs. 9 and 10).

As aforesaid, in the case of the seeds whose water content was a little over 57%, only 20 H-plants among the irradiated bore fruits, though their remainder was less, and, moreover, th growth inferior to that of the controls. Other irradiated plants did not sprout (with the exception of a few), and ceased to grow at almost the same stage. The sprouting of the irradiated seeds was not accelerated, nor the bloom, they were rather delayed.

EXPERIMENT VI.

The seeds were steeped in water for 34 hours and exposed to the rays of 10 H, 20 H, 30 H, 40 H and 50 H[1], when the water content reached 63.37% on Oct. 28. 22 hours after irradiation they were sown in humus; 20 seeds of each group of irradiated seed and 40 grains as controls.

1. It took 45 minutes to get 50H.

TABLE VII.

Days of sprouting \ Dose	Control	10 H	20 H	30 H
10/Nov.	1			
11	9			
12	5			
13	8	2		
14	9			
15	3	3		
16	2	2		
17	1	1	1	
18		3		
19	1	1		
20		2	1	
22				1
23			1	
27		2		
5/Dec.		1		
6	1			
Total	40	17	3	1

The day of sprouting and the number are tabulated in Table VII, no acceleration is seen in the irradiated seed.

On Nov. 30, the writer carefully lifted out 2 or 3 unsprouted seedlings for examination and observed that they were similar to those in Experiment V. In 20 H- and 30 H-plants, only exceptionally stout ones sprouted (3 and 1 in number). On April 2, 1918, scarcely any of the 20 H- and 30 H- plants existed and by the end of April all had died.

Only 10 H-plants developed together with the controls, but their growth was inferior to that of the latter. *Pipistrillus abramus* also attacked these plants and damaged them very much, but seeds were obtained from them (see Figs. 11 and 12 Plate XII).

The day of bloom is tabulated in Table VIII, which shows retardation of the flowering time in 10 H-plants, if compared with the controls.

TABLE VIII.

Day of bloom. \ Dose	Control	10 H
16/April	5	
17		
18	4	
19	3	
20	4	1
21	14	2
22	3	
24	6	3
25	1	
Total	37	6

TABLE IX.

Dose	Percentage of the sprouted	Percentage of the remainder to the sprouted
Control	100	92.50
10 H	85	35.29
20 H	15	0
30 H	5	0
40 H	0	0
50 H	0	0

Table IX shows the relation between the percentage of sprouted seeds to that of the remainder in flowering time (refer to Table VIII) and proves that the plants of 20 H upwards were injuriously affected. As above stated, the seeds having a water content of a little over 63% were stunted even by 10 H. As Tables VII and VIII show, it seems that there is no acceleration of sprouting and bloom, rather a retardation.

The common results of Experiments V and VI were as follows:—

1. According to the observation of unsprouted seedlings on Nov. 30, there was no difference in growth proportional to the doses given; the seeds had developed to almost the same stage, and the roots reached a length of ±2.5 cm.; but they were injured at their tip and became stumpy, though their cotyledon was healthy (at this time, the controls and the weakly irradiated reached their first step of development as little plants).

2. The time of sprouting and bloom was not accelerated and both were rather delayed.

No observation was made for the crops of Experiments V and VI, as there was damage by *P. abramus* in addition to the effect of Röntgen rays.

EXPERIMENT VII.

This experiment was undertaken to see if are-dried seeds are affected by

the Röntgen rays. SCHWARZ (1907) reported that air-dried seeds of *Vicia faba* exposed to the rays of 200 H developed just as well as the unirradiated controls. KOERNICKE (1915), on the contrary, states that there was impediment at 50 H and upwards in the case of air-dried seeds[1].

The writer repeated the same experiments, cultivating air-dried seeds[2] of "Hyôgo," whose water content was 13.75%, exposed to the rays of 40 H, 50 H, 60 H, 80 H and 150 H and sown out. On account of lack of seeds and space for sowing he could not use more than 10 seeds for each group of dose (with 20 controls); irradiation above 150 H were not tried for lack of time.

TABLE X.

Day of sprouting. \ Dose	Control	40 H	50 H	60 H	80 H
13/Nov.	1				
14	1				
15		2			
16	4		1		
17	7	2	1		
18	2	1			
19	1		1	1	
20	1	4	3	3	
21			1	1	
22	3		1		
25				1	
26				1	1
27				1	
3/Dec.			1	2	1
4		1			
One day of Jan. of '18					1
Total.	20	10	9	10	3

Table X shows the relation between the day and the number of sprouted

1. KOERNICKE uses the word "ruhende Samen" in his paper.
2. Average weight of them was 1.28 gr.

seeds. The day of sprouting is delayed proportional to the increase of dose, *i. e.*, one of the 80 H-plants sprouted one day in January '18, but the 150 H-seeds did not sprout at all above the soil. But it was evidently seen even in their dead condition at the observation on April 2, 1918, that the 150 H-seeds had germinated and developed to seedlings, whose radicle reached 2 – 3 cm. under the ground.

TABLE XI.

Day of bloom \ Dose	Control	40 H	50 H	60 H	80 H
17/April.	1				
18	1				
19	1				
20	3				
21	10	5		1	
24		2	6		
25	1			2	
27	1			1	
28		1	3	2	1
30	1				1
2/May		2		1	1
3				1	
4				1	
Total.	19	10	9	9	3

As Table XI shows, the day of bloom is delayed proportional to the doses. Moreover, it is interesting to note that the day of sprouting and bloom is delayed rather more than in the two former experiments. The retardation of sprouting may be due to the difference of stimulus; the seeds having much water by steeping may have been more stimulated than the air-dried ones. If the sprouting is delayed, so will the growth, and thus a retardation of the time of bloom will naturally take place.

The relation between percentage of sprouted seeds and the remainder at the time of bloom is shown in Table XII, as well as the fullgrown plants.

TABLE XII.

Dose	Percentage of sprouted seed	Percentage of the remainder to the sprouted
Control.	100	95
40 H	100	100
50 H	90	100
60 H	100	90
80 H	30	100
150 H	0	0

On April 2, the growth of 60 H-plants was somewhat inferior to that of controls, but in that of 50 H and down there was no difference in outward appearance. The growth of 80 H-plants was extraordinarily inferior. As aforesaid, 150 H-seeds germinated and developed to seedlings, whose radicle reached 2–3 cm.

In order to show the state of growth, the average of the number of nodes and nodes having buds is shown below:—

Subject of observation / Dose	Control	40 H	50 H	60 H	80 H
No. of nodes	9.8	9.4	9.3	7.5	5.7
Nodes having buds	8.6	8.35	8.3	6.5	6.0

(Examined on April 6)

The inferior appearance of 60 H-plants on April 2, as aforesaid, is due to this decrease in the number of nodes. In the 80 H, the development was so bad that the average-number of nodes not only decreased, but only one of them had buds on April 6.

These plants were parasited by *Bacillus Fabae* but there was no damage by *P. abramus*. Therefore their growth was very good and their fruit was cropped[1] on June 22, '18.

1. On account of illness of the writer, his friend Mr. Y. IMAI gathered the crop and classified the fruits with Mr. K. KIMURA; he asked Mr. S. NAGAI to photograph them as shown in Figs. 9–14. Without this assistance, the results of experiments V–VII would have had to be abandoned. The writer expresses his hearty thanks to these gentlemen for their kindly help.

The number of branches bearing fruit of one plant, the number of seeds and their weight (weighed in the beginning of April, '19) are respectively tabulated below :—

No. of individual	No. of branches	No. of seeds	Air-dried weight (Gr.)	
1	4	23	35.00	Control plants
2	2	12	14.50	
3	4	23	29.00	
4	3	21	30.00	
5	4	18	13.00	
6	4	20	27.50	
7	4	22	27.00	
8	4	45	48.50	
9	5	55	57.50	
10	3	14	20.00	
11	3	21	32.50	
12	3	18	22.50	
13	4	25	36.00	
14	4	18[1]	27.50	
15	4	28	34.50	
16	2	16	16.50	
17	2	12	16.50	
Fig. 13 (left)	3	14	20.00	
Fig. 13 (right)	6	75	72.50	
1	5	24	26.00	40 H-plants
2	5	28	38.00	
3	4	22	22.00	
4	5	37	42.50	
5	4	17	21.50	
6	4	24	29.50	
7	5	25	41.50	
8	3	26	32,00	
9	4	11	12.00	
10	1	4	5.00	
2	4	21	31.00	
3	3	22	23.50	

1. Including four worm-eaten ones.

No. of individual	No. of branches	No. of seeds	Air-dried weight (Gr.)	
4	3	20	16.50	50 H-plants
5	4	24	28.50	
6	4	19	25.00	
7	2	6	6.50	
8	3	20	25.00	
9	5	25	29.50	
10	2	14	16.50	
1	3	9	11.50	60 H-plants
3	4	16	17.50	
4	6	30	26.50	
5	2	5	7.50	
6	2	9	13.50	
7	3	25	28.50	
8	2	12	15.50	
9	3	13	12.50	
10	2	9	9.00	
4	4	12	13.50	80 H-plants.
6	1	1	0.67	
9	1	2	2.00	

(Note to Fig. 16: Each little heap in this figure is the crop of one plant.)

A summary of the results is shown in Table XIII.

TABLE XIII.

Subj. of observ. \ Dose	Control	40	50 H	60 H	80 H
No. of plants	19	10	9	9	3
No. of branches having fruit	68	40	30	27	6
Sum of the grains of seeds	480	218	171	128	15
Total weight (gr.)	59.05	270.1	202.0	141.5	16.17

The amount of crop decreased proportional to the doses given, and apparently showed a negative stimulation of the rays. Here the writer can

not accept G. SCHWARZ's results, though the water content[1] of his seeds was not known. That is, in the writer's experiment, even in the air-dried seeds, if their water content be about 14%, they are affected, and the impediment in growth obviously appeared at 80 H and up. The 80 H-plants were stunted so badly that only 15 grains of seeds were obtained from 3 plants, *i. e.*, only stout individuals developed so far that they bore fruit. But the 150 H-seeds germinated and developed to seedlings, the radicle reaching 2–3 cm. under the ground. Thus the writer verified KOERNICKE's result.

IV. Germination Experiments.

They were performed on the seeds of "Hyôgo," a race of *Vicia faba* (1918-crop), in Experiments VIII and IX.

As to the irradiation for these two experiments, the same care was taken as in the case of others; the only difference being that the tube distance was 15 cm. in this case.

EXPERIMENT VIII.

In order to see if the presence of a seed coat affects the sensibility to Röntgen rays and if there is acceleration of germination in steeped irradiated seeds, this germination experiment was performed. The seed coat of a part of these seeds was peeled so as to uncover the plumule and radicle, and then these peeled and unpeeled seeds were exposed to the rays of 20 H, 40 H and 50 H at the same time. The tip of the radicle of peeled seeds became brown by the irradiation. They were sown 2 and $4\frac{1}{2}$ hours after irradiation in a square pot, with washed sand, and divided into four compartments. The same number of controls, as 20 H-, 40 H- and 50 H- seeds, peeled and unpeeled, were placed in these four sections of the pot. The writer used two sets of these pots, and placed them near a window on the south side of a corridor. One can keep environmental conditions fairly constant in sowing them in a pot, but can not do so in the field.

1. Absolutely dried seeds by "water-bath" have no power of germination; the writer's experiments of this kind by using the seeds of *Vicia faba*, *Oryza sativa* and *Phaseolus vulgaris* gave always negative results, so the seeds (trockene Samen) of SCHWARZ may not have been of such nature, and, perhaps may not have contained less water than air-dried seeds.

The seeds were irradiated on April 19, 1919 and sown in the evening of that day. The controls sprouted on April 26. The seedlings were photographed on April 27 (Fig. 17). The lower row represents those from peeled seeds. From this experiment it will be seen that,

1. No conspicuous difference was seen in the growth of seedlings irradiated in different doses.

2. The seedlings from irradiated seeds whether peeled or not, grew alike.

3. The tip of the radicles from irradiated seeds is stunted and harder than that of normal seedlings.

4. There is no acceleration of germination in irradiated seeds.

By this experiment the writer could verify the common results of several former experiments *i. e.* "the seedlings which do not appear above the soil cease to grow at almost the same stage, and there is no difference in growth proportional to the doses given".

Experiment IX.

In order to see if there is acceleration of germination in air-dried seeds irradiated weakly, the following experiment was performed.

If air-dried seeds, with a water content of 10.49% were exposed (June 25, 1919) to rays of 7 H, 10 H and 15 H[1]. $8\frac{1}{3}$ hours after irradiation they were steeped in water for 12 hours, and then sown in a square pot with washed sands, and divided into four compartments.

The writer recognized such a seedling as of perfect germination, the plumule of which protrudes from the seed coat, and examined the seedlings at 10.20 A.M. on June 30. The germination-percentage was as follows:—

Controls	60%
7 H	26.6%
10 H	46.6%
15 H	25.0%

That is, there is no acceleration of germination in the irradiated seeds. As Fig. 18 shows, they are in almost the same state of growth.

1. It took 18.5 minutes to get 15 H.

They were photographed immediately after examination, and then wrapped into wet paper in a box (for carrying). 30 minutes after again planted in the sands and their growth observed. The growth of 7 H- and 10 H-plants was better compared to the controls and the 15 H, but the writer could not measure their lengths, for rats damaged them all the night before the measurement. By this fact, it is supposed that 15 H may not cause a good stimulation in this case.

KOERNICKE states that the effects of X-rays upon *Vicia faba* differ according to their race. In the steeped irradiated seeds of "Sengoku-kurome," as aforesaid, 20 H-plants were best in growth and maximum in dry-weight compared with the controls and the other irradiated ones. These two results (Experiment III and IX) seem to contradict each other, but they can be explained by KOERNICKE's results or by the difference of environmental conditions.

EXPERIMENT X.

Seeds of "Wase-soramame," which had been steeped in water for a few days, so that the tips of the radicles appeared from the seed coat, were exposed to the rays for one hour and then sown in sands, one hour after irradiation, on April 27, 1922.

Half of them developed a little, the other half sprouted and the young shoots and roots reached $\pm 1.5 - 3.0$ cm.

The X-ray bulb used for this experiment was ÒKURA's water-cool tube after MÜLLER, the hardness of which was $\pm 10.5°$ WEHNELT. Spark length was 15 cm. and the tube current ± 2.5 milliampères. Tube distance 30 cm. The writer made the irradiation under the direct control of Dr. N. FUJI at the Röntgen laboratory of the Agricultural Experiment Station, Department of Agriculture and Commerce, Nisigahara, Tôkyô.

A water cell was inserted between the bulb and the seeds. The cell is made of two aluminium disks 0.3 mm. thick supported by brass rings of 1 cm. height and provided with two short brass tubes for the in- and outflow of water. This device was used to prevent the thermal factor entering into the experimentation. 10 minutes' exposure corresponds to 8 H of HOLZKNECHT's unit.

The steeped seeds in the condition stated above, were stunted severely by one hour's exposure (corresponds to 48 H).

V. Discussion.

Here, the writer intends to compare the results of other authors with his own and then to sum up his results.

E. SCHWARZ says that there is acceleration of growth by weak irradiation, but he converted the time of exposure into dose, *i. e.*, when $\frac{1}{2}$ H is obtained by continuous exposure of 30 minutes, 5 minutes exposure gave $\frac{1}{2}$ H, so that, by $2\frac{1}{2}$ minutes $\frac{1}{24}$ H was obtained. In the strict meaning, these doses are questionable. By 5 minutes' exposure $\left(\frac{1}{12}\mathrm{H}\right)$, air-dried seeds were severely stunted, according to his results, but this cannot be accepted from the author's results of experiment VII, that is, in the air-dried seeds, with a water content of 13.75%, 40 H-, 50 H-, 60 H- and 80 H-plants bore fruit, though the amount of the crop decreased proportionally to the doses. So the writer presumes that he gave much larger doses than he states.[1] He says nothing about the seeds used, on both the race and the weight; for *Vicia faba* has large individual deviations, so that special care must be taken. He seems to have used *Vicia faba* without these precautions, and, moreover, he sowed 3 in a pot respectively and placed them near the window, so the plants grew excessively, according to his text figure, and he measured the length as the difference in growth proportional to the doses given. The writer thinks that it is not good to draw such conclusions from so small a number of experiments without paying attention to the above considerations. If his results are compared with those of the writer (Experiment III), they become doubtful, *i. e.*, in the seeds with a water content of 50%, 20 H show a positive stimulation, and one which was irradiated by a dose of more than 20 H developed.

KOERNICKE sowed irradiated seedlings. This is not a good treatment for *Vicia faba*, because transplanting is harmful to the Leguminosæ, so the plants received two impediments, the rays and by external injury. Therefore, an

1. Dr. FUJINAMI agrees with the writer's opinion.

impediment of growth will naturally take place, and it is not reasonable to conclude that his results are caused only by the effect of the rays. He exposed seeds with radicles about to shoot forth as the result of a few days' steeping, to rays of 10X (=5 H) and 15X(=7.5 H), and observed a conspicuous impediment of growth 9 days after the irradiation, he gives illustrations in wood cuts in his paper of 1915 (Fig. 2). These results are also questionable compared with the above stated results of the writer.

G. SCHWARZ states that he cultivated dried seeds (trockene Samen) exposed to the rays of 20 H and observed no difference in growth compared to the unirradiated controls, but in the writer's experiments of air-dried seeds, with a water content of 13.75%, a conspicuous impediment appeared at 80 H (the sprouting percentage of 80 H-plants was only 30%, while that of the controls was 100%), and no 150 H-plants appeared above the soil. The amount of crop decreased proportional to the doses used. As the writer explained at the end of the statement to Experiment VII, it is to be presumed that the seeds used for his experiments must have been air-dried, not absolutely dried; for this latter method entirely deprives the seeds of germinating power. It is to be regretted, that he did not show the water content of the seeds.

SCHMIDT's experiments were few in number and seeds used, and one may presume from the photographs in his paper that he took no particular care as to the method of cultivation (to avoid the special effect of surroundings for the plants situated on the edges). So his experiments lack accuracy. Such an experiment is not good where the seedlings are exposed to the rays and then planted again into the soil, as transplanting is harmful to Leguminosæ.

The writer is rather inclined to believe that the increase of the amount of crop due to irradiation as described in the paper by YAMADA and NAKAMURA may not be a real one. (Had they taken more care in cultivating the plants, their results might agree with mine.)

The writer took great pains to get accurate results, heeding the faults in experimental methods of other investigators. As *Vicia faba* has no pure line, he could not use it in the present experiments but he used a special race of it and weighed the seeds for averaging their individual deviation, and special care was taken for avoiding the effect of surroundings to the edges.

The writer was specially interested in the relation between sensibility to Röntgen rays and the water content of seeds, so in the seeds their water content was determined. As already stated, other investigators also pay attention to this point. For example, G. SCHWARZ (1907) says, "die Röntgenlichtempfindlichkeit der Zellen ist ihrer Stoffwechselgröße grade proportional" (p. 972). When the amount of water is less, impediment appears only by a rather strong dose, and vice versa. This fact is also observed by KOERNICKE (1915) "auch der Plasmareichtum und Wassergehalt der Zellen muß bei der eventl. Lösung dieser Frage in Betracht gezogen werden" (p. 429). Therefore, SCHWARZ's result on the 200H-seeds of *Vicia faba,* which developed just as the unirradiated controls did, is open to doubt. In KOERNICKE's experiment, an impediment of growth appears at 50 H in the case of air-dried seeds. The relation between sensibility to Röntgen rays and water content of seeds at the time of irradiation is important and of interest. But these authors did not indicate exactly the water content of the seeds used, so that their results cannot be directly compared with those of the writer.

KOERNICKE states that only *Vicia faba* among ten kinds of experimental plants was affected by X-rays, the others showed neither a positive nor a negative effect, and the germination of cereals, in particular, is not accelerated nor is there any effect in their growth, but the writer observed the acceleration of germination in *Oryza sativa*[1] and *Phaseolus vulgaris*[2] (white seeded varieties). Therefore he cannot agree with him.

Plants differ in sensibility to Röntgen rays according to the species. In other words, plants make selective absorption. So the writer thinks the effect cannot be definitely stated as regards a certain plant, unless a large number of experiments have been made.

The following are the special results obtained from the writer's experiments :—

(1) Though the seeds are exposed to Röntgen rays of high dose, their development is not stopped immediately. They germinate and develop for a certain period.

(2) Though the impediment of growth is caused by the dose which is inversely proportional to the water content of seeds, the injured plants cease

1. In air-dried irradiated seeds, 5 H-10 H was the effective dose for acceleration.
2. Of 5 H-, 10 H-seeds, the germination of the 5 H-seeds was accelerated.

to develop at almost the same stage of growth under the ground. There is no difference in growth proportional to the doses given (when the steeped seeds contain same amount of water by steeping).

(3) When the dose of Röntgen rays exceeds a certain limit, it does not induce a visible difference in the state of impediment proportional to the dose. The effect of Röntgen rays in these cases is no more than an injurious stimulation for the seeds—of course, this limit varies with the water contents of the seeds at the time of irradiation.

From these facts, the writer thinks it may be presumed that strongly irradiated seeds are particularly affected at the plumule and radicle, and metabolic change of these parts may take place, and when this change reaches a certain stage, the seedlings cease to develop.

NEUBERG's statement in his paper entitled "Beziehungen des Lebens zum Licht" may be of interest in this connection: "Das sind Reaktionen, die den Ablauf des Stoffwechsels in einer belichteten Zelle völlig ändern können. Da die Photokatalysen den Abbau hochmolekularer Substanzen, ähnlich wie Enzyme, besorgen, kann man sich vorstellen, daß bei darniederliegendem Stoffwechsel das Licht eine anregende Wirkung dadurch entfaltet, daß es in gewissen Sinne die Rolle von Fermenten übernimmt oder durch Bildung von anomalen und besonders reaktionsfähigen Spaltungsprodukten (Aldehyden, Ketosäuren u. dgl.) ungewöhnliche Reize ausübt" (p. 54).

A summary of the results of our experiments, in addition to the specially stated three facts, is as follows:—

(1) Though air-dried seeds with a water content of 10.5% were exposed to rays of 7H–15H, there occurred no acceleration of germination.

(2) Though air-dried seeds having ca. 14% water are exposed to rays of 40H and up and steeped seeds of 57% up to 10H, the day of sprouting and bloom is not accelerated, they are rather delayed according to the increase of the dose.

(3) The effect of X-rays varies with the water contents of the seeds at the moment of irradiation. Even in the air-dried seeds an impediment occurred according to the water content and the doses given.

(4) Seeds having a water content of 57% and up seem to have been severely affected by 20 H up.

(5) From the fact that seedlings from irradiated seeds, whether peeled or not, grow alike, it is presumed that the presence of the seed coat does not affect the germination. That is, a dose above 20H became an injurious stimulation for the plumule and radicle in steeped irradiated seeds with ca. 58% water.

(6) The sprouting of air-dried irradiated seeds is delayed more than that of steeped irradiated ones. The retardation of sprouting may be due to the fact, that the latter, whose water content is large, are more stimulated than the former having less water. If the sprouting is delayed, the growth will do so, and a retardation of the time of bloom will naturally take place.

At the end of this paper, it is the writer's pleasant duty to acknowledge his indebtedness to Dr. Kôiti Fujinami, who has made irradiations for him, and helped him in every way throughout the progress of the work, and to Professors Kiichi Miyake and Keita Shibata who have given kind advice and criticism. The writer is also indebted to Dr. Matarô Nagayo, who kindly made arrangements with the Morimura Hômei Kwai to defray the expenses of this study. Thanks are also due to Prof. Naohide Yatsu for his kindness in making valuable suggestions as to the form and other particulars of this paper.

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EXPLANATION OF PLATES.

PLATE XI.

Fig. 1. Seeds of "Sengoku-kurome" were steeped in water for 46 hours (when the water contents reached 57.49%) and exposed to rays on March 17, 1917. On the next day they were sown 21 hours after irradiation in Marquis TOKUGAWA's field at Azabu, Tôkyô. The figure shows the conditions at the end of the experiments on May 10.

(Of ten seeds of each lot these are the remainder of the seedlings, while the rest were found decayed or altogether missing.)

Fig. 2. Seven seeds, from the batch of Experiment I, were sown 17 hours after irradiation in the soil of large wooden frames and 7 *sun* pots. The picture represents their condition at the end of the experiments on May 22, 1917 (these are the remaining seedlings, from seven of each lot.)

Fig. 3 and 4. After 31 hours steeping, the seeds of "Sengoku-kurome" were irradiated, their water contents reaching 50%, on March 31, 1917. They were sown, on April 1, 17 hours after irradiation in the field of our institute. Photographed on May 1. They are shown standing in the field.

Fig. 5. Conditions of plants of each lot from Figs. 3 and 4 at the end experiment, June 16.

Fig. 6. Seedlings which were used for the culture in KNOP's solution. Two seeds, from the batch of Experiment III, were sown in saw-dust on April 2. On April 9 they were put into KNOP's solution and photographed on April 16. The seedlings of 50 H (due to injury) and 80 H up did not develop further than this stage.

Fig. 7. Condition of the above water-cultured plants 22 days after treatment, on May 1, A black point of a 30 H-plant which exists at the lower part of a shoot was caused by injury. Therefore, the growth is inferior to that of the others.

Fig. 8. Condition at the end of experiments, on June 16, of the plants of Fig. 6.

Fig. 9. Plants grown from the seeds of "Hyôgo" which were steeped for 24 hours before irradiation when the water content reached 57.32% irradiated on Oct. 28, '17 and sown the next day. State on June 22 at the end of experiments.

PLATE XII.

Fig. 10. Fruits from the above plants. These plants of Experiment V were seriously damaged by *Pipistrillus abramus*. The number shown on some plants and fruits of 20 H coincides in two figures; they are the number of individuals in the field.

Fig. 11. Plants grown from seeds of "Hyôgo" which were steeped 34 hours before irradiation (when the water content reached 63.37%) and irradiated on Oct. 28, '17. On the next day they were sown, 22 hours after irradiation, in the field of our institute (the field for Experiment III). State at the end of experiment, June 22, '18.

These plants of Experiment VI were also severely damaged by *Pipistrillus abramus*.

Fig. 12. Fruits of above each lot. In two figures, the coinciding number of 10 H-plants and fruit are the number of individuals in the field.

Fig. 13. The state (at the time of crop) of plants grown from air-dried seeds of "Hyôgo," whose water content was 13.75%, were irradiated on Oct. 28, '17, and, on the next day sown, 22 hours after irradiation, in the field of our institute. Photographed on June 22, '18.

Fig. 14. Fruits of above each lot. In two figures, same number in different lots, *e. g.*, No. 8 is in 40 H- and 60 H-fruits and No. 4 is in 60 H- and 80 H-fruits, but these are simply the number of individuals in the field. Fig. 14. represents the fruits of each lot in Fig. 13.

Fig. 15. Shows the seeds of each lot. The numerical number of each lot is that of individuals in the field and common to three figures (Figs. 13–15).

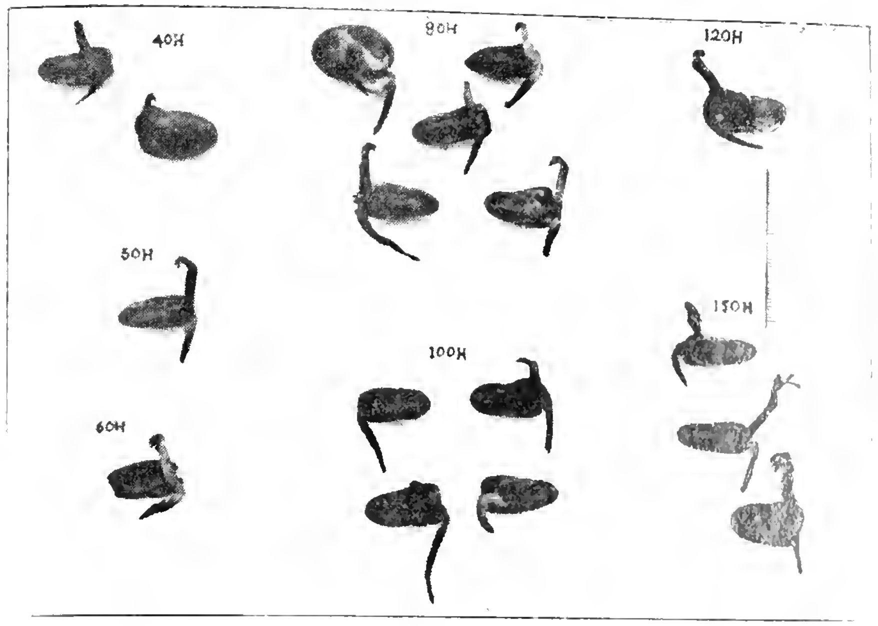
Fig. 16. The whole crop of each lot of Experiment VII, and one pile is the crop from one plant. It can be seen that the amount of crop decreases proportionally to the increase of doses given, and that of the 80 H is extraordinary small.

Fig. 17, Seedlings grown from the seeds of "Hyôgo" which were steeped for 77 hours (when the water content reached 57.87%) and irradiated on April 19, 1919. On that evening they were sown in sands a few hours after irradiation. Photographed in the forenoon of April 27. The lower row represents those from peeled seeds. (Experiment VIII).

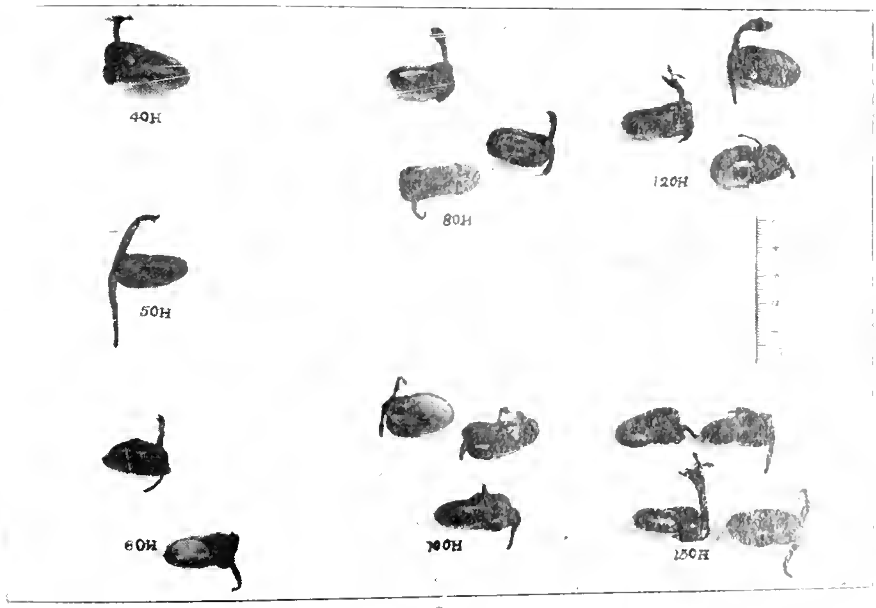
The irradiated seeds are almost in the same stage of growth and no difference in growth is seen proportional to the doses given.

Fig. 18. Seedlings grown from the air-dried seeds of "Hyôgo," water contents of 10.49%, irradiated on June 25, 1919 and sown in sand. Photographed on June 30.

No sign of acceleration of germination can be seen (Experiment IX).


40H
90H
120H
50H
150H
100H
60H

1.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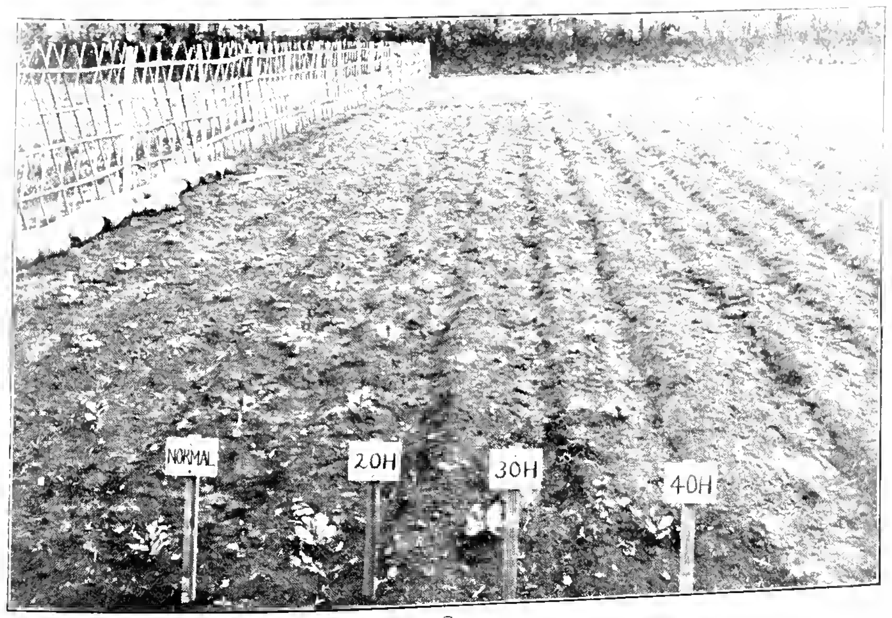
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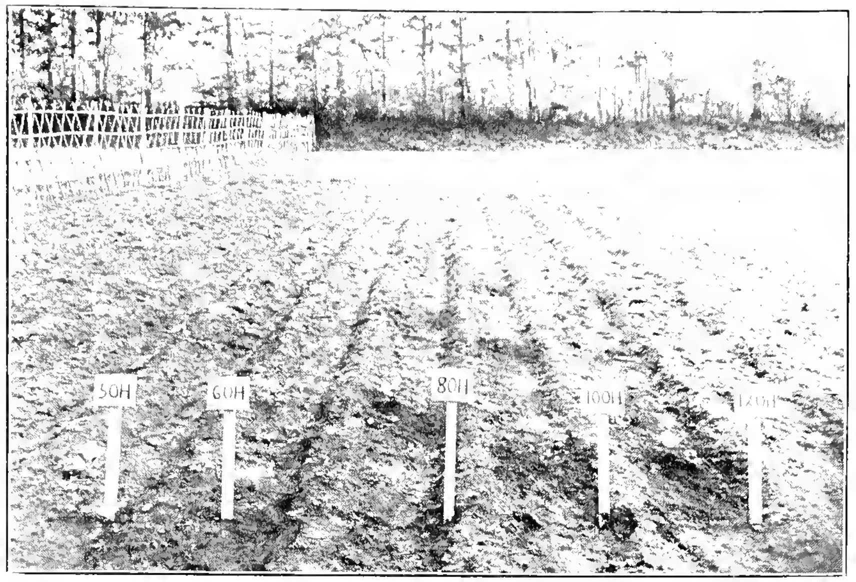
20H
30H
40H

3.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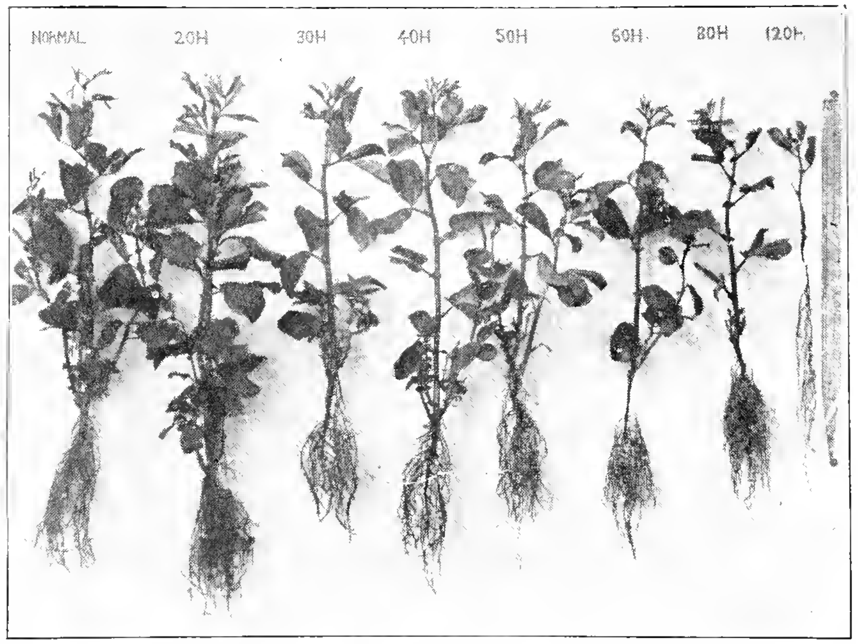
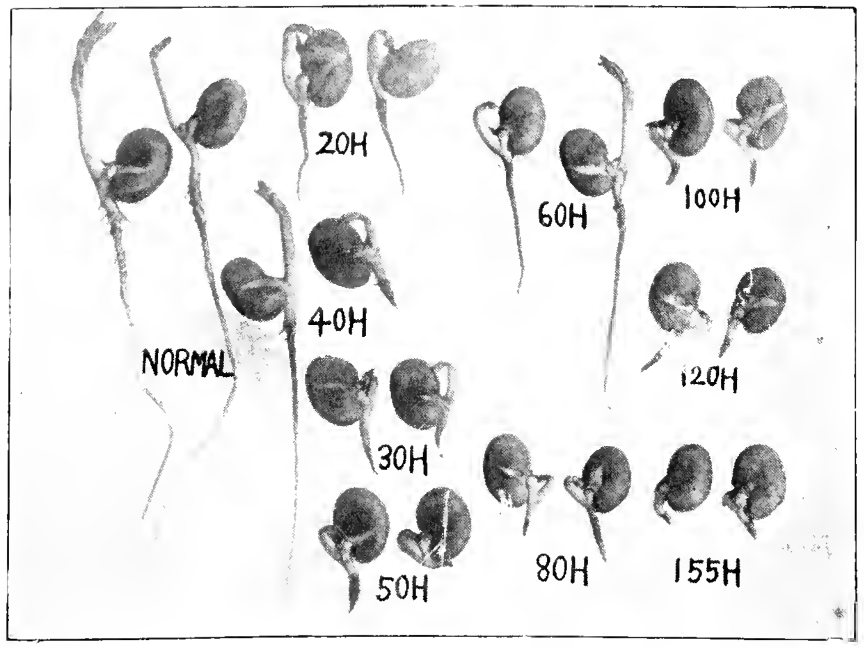
120H

4.


NORMAL
20H
30H
40H
50H
60H
80H
120H

5.


20H
60H
100H
40H
NORMAL
120H
30H
50H
80H
155H

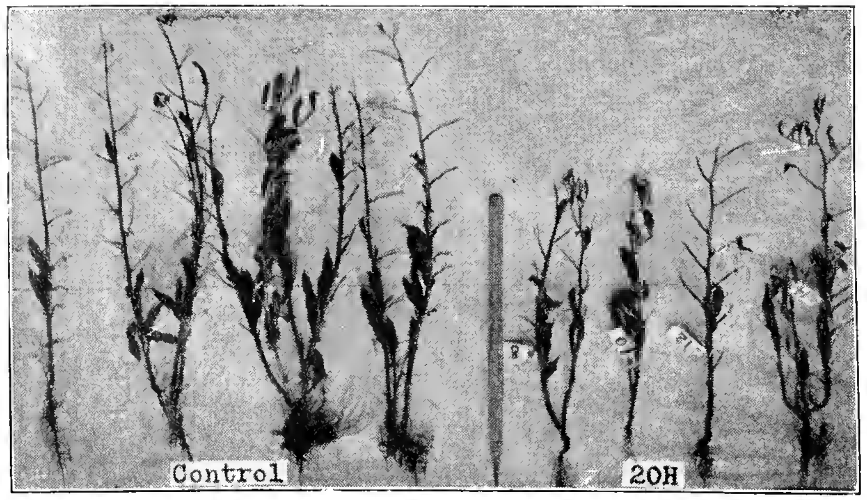
6.


6OH
40H
3OH
2OH
Normal

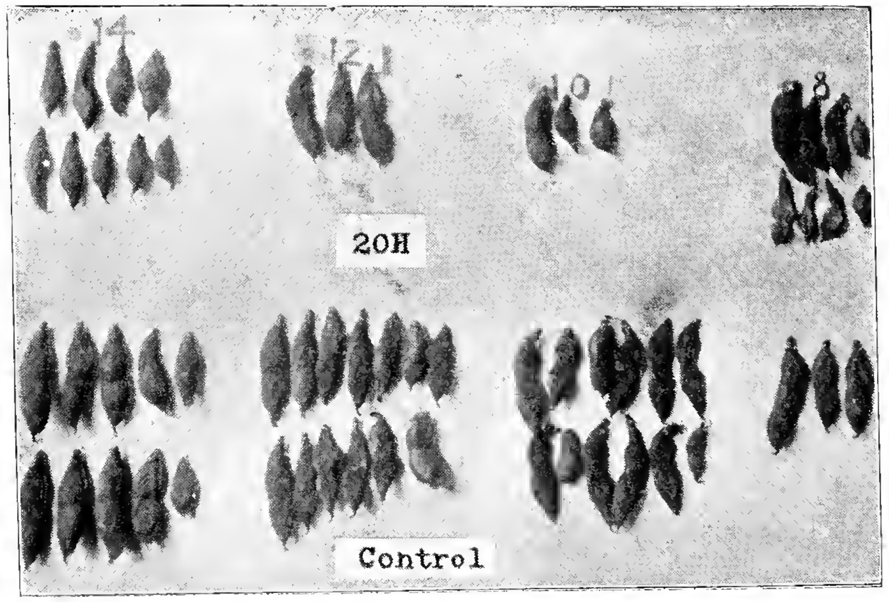
7.


NORMAL
20H
30H
40H
60H

8.


Control
20H

9.



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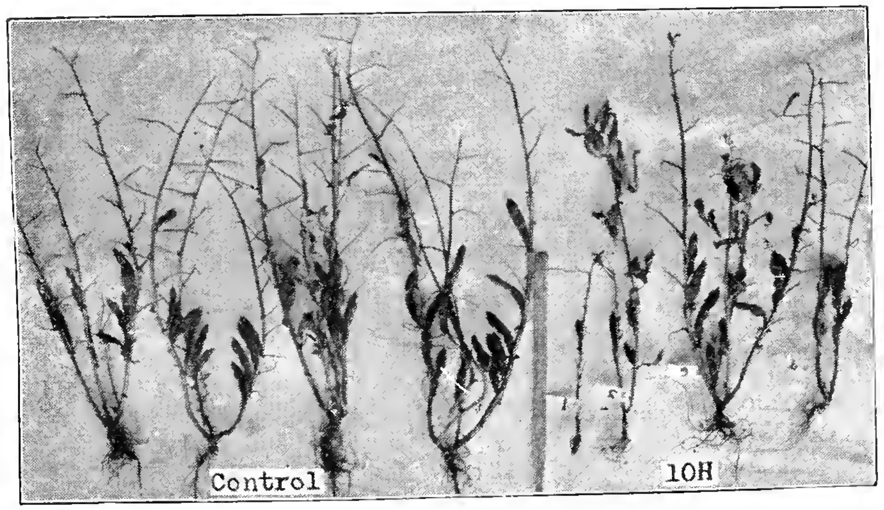

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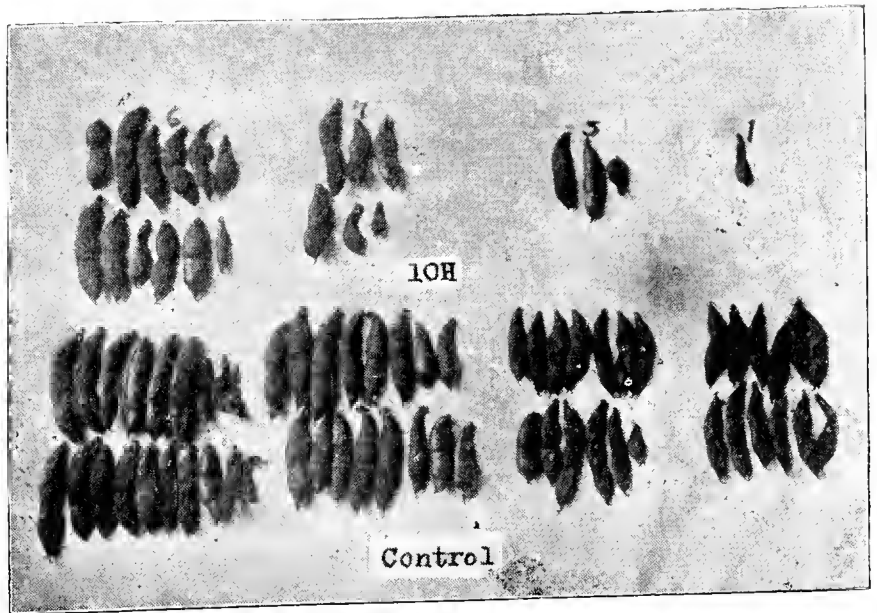

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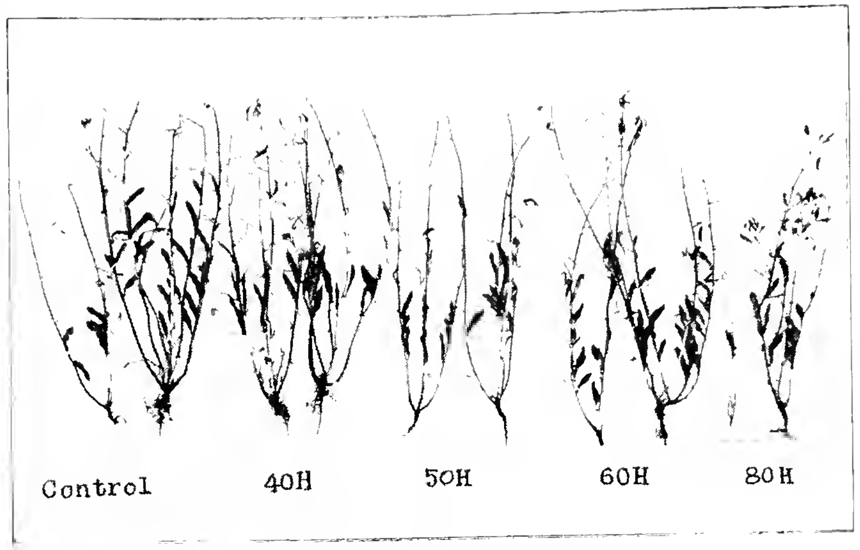

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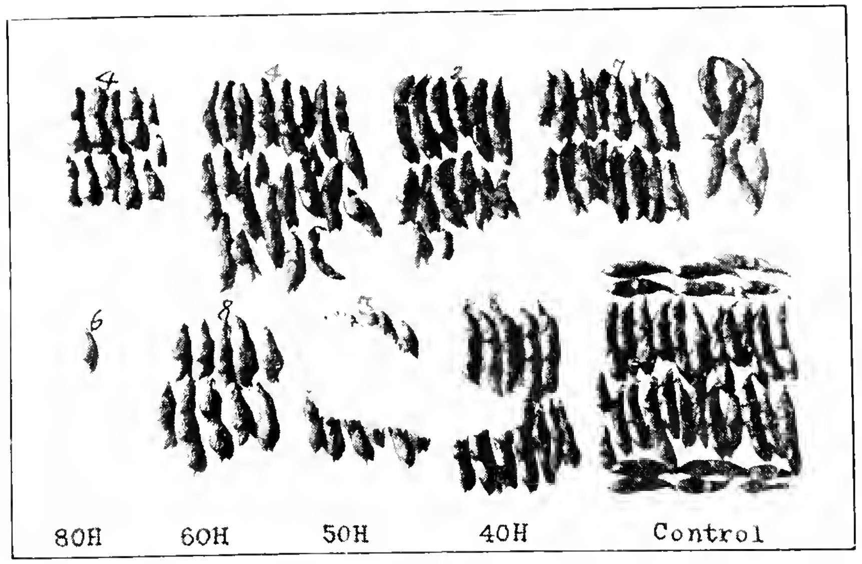

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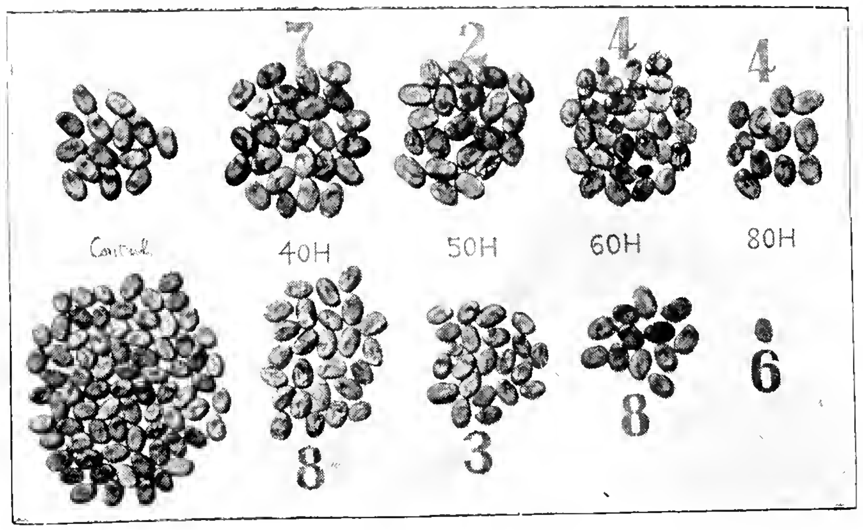

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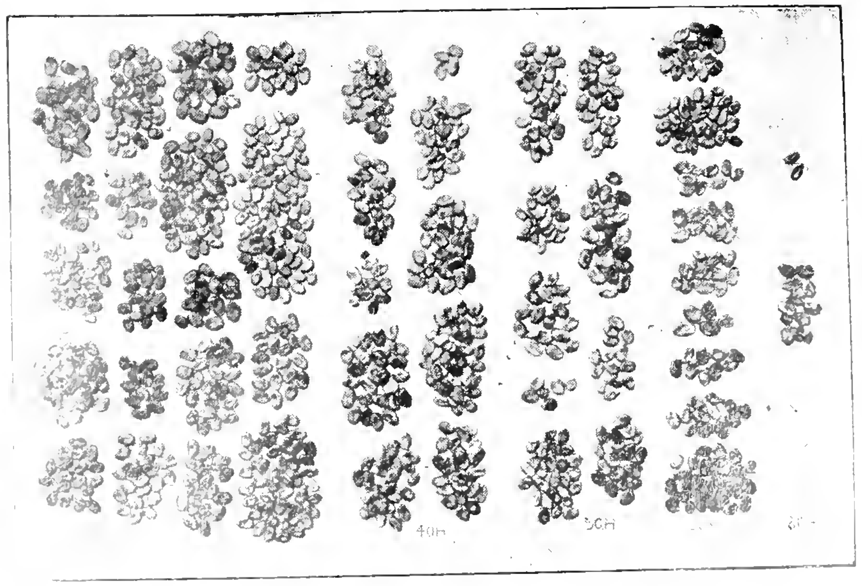

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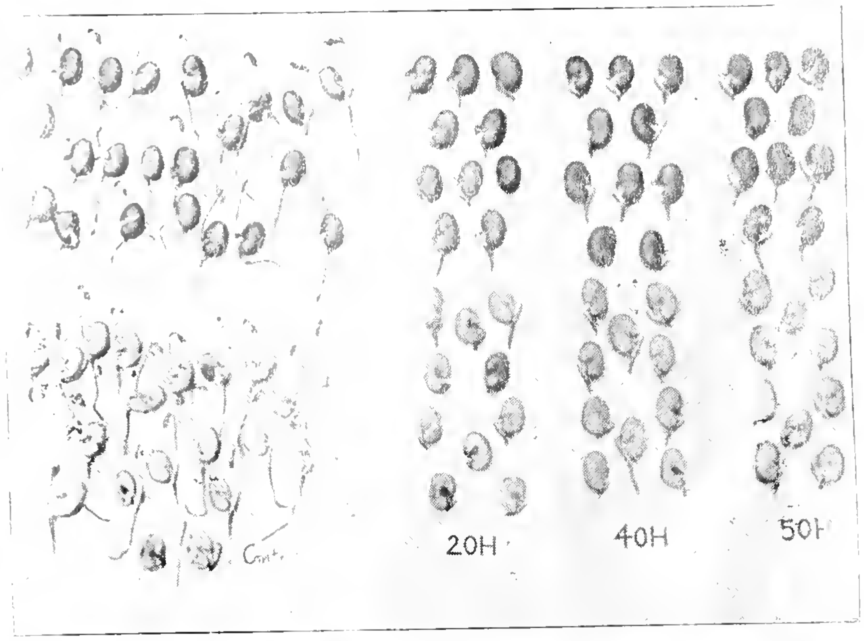

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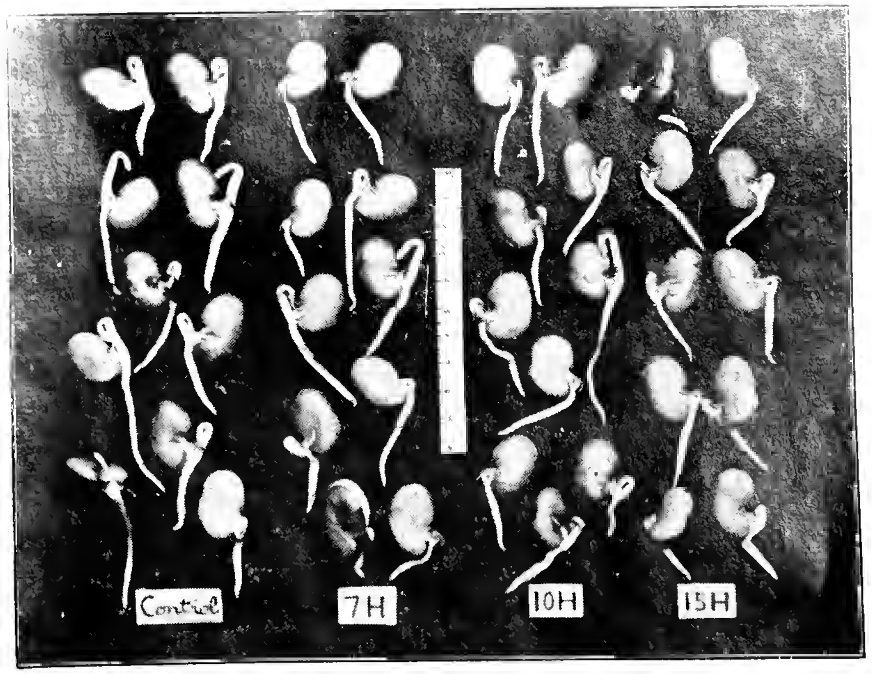

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